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REPORTS

OF THE

COMMISSION

APPOINTED BY

THE ADMIRALTY, THE WAR OFFICE, AND
THE CIVIL GOVERNMENT OF MALTA,

FOR THE INVESTIGATION OF

MEDITERRANEAN FEVER,

UNDER THE SUPERVISION OF AN

ADVISORY COMMITTEE

OF

THE ROYAL SOCIETY.

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PART IV.

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I. FURTHER NOTES ON THE ISOLATION OF THE *MICROCOCCUS MELITENSIS* FROM PERIPHERAL BLOOD; AND EXPERIMENTS ON THE DURATION OF LIFE OF THIS MICROBE IN EARTH AND IN WATER.

By Staff-Surgeon R. T. Gilmour, R.N.

(Received August 28, 1905.)

The method of procedure employed was similar to that described in my previous paper.* The cases selected for this series of experiments had well-marked symptoms of Mediterranean Fever, and in no case was the agglutination reaction less than 1 in 50. Control experiments were made to ascertain whether the microbe was present in relatively large quantities of blood. From 1 to 3 c.c. of blood and 30 to 50 c.c. of broth were used for this purpose.

Cases XX and XXXIV are interesting. In the former the *Micrococcus melitensis* was isolated during a relapse on or about the 300th day from the date of the patient first going sick. The latter is a case of Mediterranean Fever occurring during convalescence from enteric.

Case XX, D. J., Lieutenant, R.N.—This officer was admitted into hospital in December, 1903, for Mediterranean Fever. The symptoms were well marked, with an agglutination reaction of 1 in 200. He was discharged to duty in January, 1904. In April, 1904, he forwarded me his serum, and as it only reacted 1 in 10, I gave him a favourable prognosis. At the end of September, 1904, he got very wet whilst out shooting in the Greek Islands, and went sick about 14 days afterwards with fever. On admission into hospital on October 15, 1904, he had well-marked Mediterranean Fever, with an agglutination reaction 1 in 100; later, 1 in 400. On November 4, 1904, about the 300th day since date of first going sick, a pure growth of *Micrococcus melitensis* was recovered from his blood.

Case XXXIV, J. C.—This man was received into hospital with well-marked symptoms of enteric fever: dry, brown tongue, diarrhœa, intestinal hæmorrhage, and an agglutination reaction of 1 in 400 to the *B. typhosus* and negative to *Micrococcus melitensis*. On November 6, 1904, the 7th day of disease, 3 c.c. of blood were extracted from the right median basilic vein and disposed of as follows:—1 c.c. was passed into 19 c.c. of broth (A), 1 c.c. into 9 c.c. (B), and 2 c.c. into 50 c.c. (C). From (A), broth tubes were inoculated with various quantities of emulsion, containing from 0·0025 to 0·05 c.c. of blood. From (B), plate cultures were inoculated with 1 c.c. of emulsion (0·1 c.c. of blood). These tubes and plates remained sterile. Flask (C) showed turbidity after 24 hours, and by the 2nd day contained a profuse growth of the typhoid bacillus. The fever ran an ordinary course, but when the temperature had remained normal for 15 days it again rose, and patient's serum was now found to react both to *Micrococcus melitensis* and *B. typhosus* 1 in 50. On January 20, 1905, the 82nd day of the enteric attack, blood cultivation gave a pure growth of the *Micrococcus melitensis*.

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* Reports of the Commission, Part I, p. 73.

In an experience of two years and a half with Malta Fever I have never found enteric and Mediterranean Fever running concurrently, but I have come across several cases of the latter immediately following the former.

Deductions to be drawn from these experiments :—

(1) That *Micrococcus melitensis* is found in the peripheral blood of about 82 per cent. of cases of Mediterranean Fever. In the 45 cases examined, no control was made in 8, and in 1 the cultures were contaminated. Of the remaining 36 the microbe was isolated in 29, and also in 1 with no control.

(2) That the number of *Micrococcus melitensis* per cubic centimetre of blood is small, rarely reaching 100. Out of the 30 cases quoted above, in only 6 did they number 100 or more. Largest number found, 400 per cubic centimetre.

(3) That the *Micrococcus melitensis* can be recovered as early as the 2nd day and as late as the 300th day of the disease.

(4) That patients convalescent from enteric may contract Mediterranean Fever, so that the former disease does not appear to confer immunity against the latter.

The experiments (p. 5) were undertaken at the suggestion of the Committee of the Mediterranean Fever Commission. The results obtained were similar to those of Horrocks' and Bassett-Smith, with the exception of the life of *Micrococcus melitensis* in sea-water. In sterile sea-water it appeared to me to exist only for a very short time—about 13 days; in non-sterile sea-water the plates were so crowded out with other bacteria that I failed to isolate it after the 1st day.

The following deductions can be drawn from these experiments :—

1. That the *Micrococcus melitensis* can exist for considerable periods outside the body, but that it does not multiply.
2. That it can exist in dry, sterile garden soil for at least 60 days.
3. In sterile tap-water for at least 42 days.
4. In sterile sea-water for at least 13 days.
5. In non-sterile tap-water for at least 7 days.

Experiment.	Day of disease.	Approximate number of *Micrococcus melitensis* per c.c. of blood.
XIV …………	6	0·0
XV …………	189	0·0
XVI …………	16	40·0
XVII …………	18	Present in control
XVIII …………	32	0·0
XIX …………	40	0·0
XX …………	300	Present in control
XXI …………	7	0·0
XXII …………	2	Present in control
XXIII …………	9	0·0
XXIV …………	29	Present in control
XXV …………	8	20·0
XXVI …………	3	Present in control
XXVII …………	12	,, ,,
XXVIII …………	49	,, ,,
XXIX …………	34	,, ,,
XXX …………	30	,, ,,
XXXI …………	10	400·0
XXXII …………	40	Present in control
XXXIII …………	45	,, ,,
XXXIV …………	?	,, ,,
XXXV …………	7	0·0
XXXVI …………	12	50·0
XXXVII …………	5	0·0
XXXVIII …………	180	0·0
XXXIX …………	40	333·3
XL …………	4	0·0
XLI …………	11	100·0
XLII …………	17	0·0
XLIII …………	15	100·0
XLIV …………	6	Present in control
XLV …………	12	,, ,,

A. *Duration of Life of* Micrococcus melitensis *in Dry, Sterile Garden Soil.*

Experiment 1.—February 15, 1905. The soil was inoculated with 1 c.c. of an eight-day-old broth sub-culture. The flask was then placed in a dark cupboard, and shaken frequently, the soil being allowed to dry naturally.

Micrococcus melitensis was recovered on the 60th day.

B. *Duration of Life of* Micrococcus melitensis *in Non-sterile Tap-water.*

Experiment 1.—February 2, 1905. One hundred cubic centimetres of tap-water were inoculated with the whole of an eight-day-old agar slope culture.

Micrococcus melitensis was isolated on the 7th day.

C. *Duration of Life of* Micrococcus melitensis *in Sterile Tap-water.*

Experiment 1.—February 3, 1905. Fifty cubic centimetres of tap-water were sterilised by heating to 120° C. in an autoclave for 30 minutes, and were then inoculated with the whole of an eight-day-old agar slope. The flask was kept in a dark cupboard.

The *Micrococcus melitensis* was recovered up to the 6th day.

Experiment 2.—This experiment was repeated with a four-day-old sub-culture.

Micrococcus melitensis was recovered up to the 42nd day.

Experiment 3.—February 8, 1905. Ten cubic centimetres of tap-water, sterilised in the autoclave at 115° C. for twenty minutes, were inoculated with the whole of a five-day-old agar sub-culture.

Micrococcus melitensis was recovered on the 19th day, but not later.

Experiment 4.—This experiment was again repeated. The agar sub-culture used was 12 days old.

Micrococcus melitensis was recovered on the 23rd day.

D. *Duration of Life of* Micrococcus melitensis *in Non-sterilised Tank-water.*

Experiment 1.—February 15, 1905. The water was obtained from a foul drinking tank, contaminated with large quantities of animal and vegetable matter.

The *Micrococcus melitensis* could not be recovered two days after inoculation.

E. *Duration of Life of the* Micrococcus melitensis *in Sterilised Tank-water.*

Experiment 1.—February 15, 1905. The same water was used as in the last experiment, but in this case it was sterilised for 30 minutes at 100° C.

Micrococcus melitensis was recovered on the 12th day after inoculation.

F. *Duration of Life of* Micrococcus melitensis *in Tank-mud.*

Experiment 1.—February 15, 1905. Mud, unsterilised. A glass flask was filled to a depth of one inch with fairly liquid mud, which was inoculated with 5 c.c. of a 12-day-old broth culture.

The *Micrococcus melitensis* could not be recovered from this unsterilised mud two days after inoculation.

G. *Duration of Life of* Micrococcus melitensis *in Sterilised Tank-mud.*

Experiment 1.—Mud sterilised.

The *Micrococcus melitensis* was recovered from this sterile mud on the 21st day after inoculation.

H. *Duration of Life of* Micrococcus melitensis *in Unsterilised and Sterile Sea-water.*

Experiment 1.—February 2, 1905. One hundred cubic centimetres of unsterilised sea-water were inoculated with the whole of an eight-day-old agar slope.

The microbe was recovered from non-sterile sea-water one day after inoculation, but not afterwards.

Experiments 2, 3 *and* 4.—February 24, 1905. One hundred cubic centimetres of sea-water were heated to 120° C. in an autoclave for 15 minutes, and were then inoculated with the whole of a nine-day-old agar slope.

Micrococcus melitensis was recovered from No. 2 on the 13th; from No. 3 on the 13th, and from No. 4 on the 12th day after inoculation.

II. THE AMBULATORY TYPE OF CASE IN MEDITERRANEAN OR MALTA FEVER.

By Staff-Surgeon E. A. Shaw, R.N.

(Received November 25, 1905.)

The existence of this type of case amongst a people with whom a specific fever has been for scores of years endemic had long been surmised. The importance of such cases as sources of infection has been amply demonstrated by Koch in his anti-typhoid campaign in the Rhine provinces in 1902, but with regard to Malta Fever the existence of such cases has hitherto been merely a matter of conjecture and not of absolute knowledge.

Accordingly in June of 1905, I set myself to the task of investigating the existence or otherwise of this type of case of Malta Fever amongst the Maltese. For this purpose it was deemed necessary to have available a large number of Maltese actually in full work, each readily identifiable, and under control, so that any one individual could be readily got at for the necessary observations. The method contemplated was to examine the blood of a considerable number for agglutination reaction, and further to make a bacteriological examination of the blood and urine for *Micrococcus melitensis* of such individuals as might present a well-marked agglutination reaction. For obvious reasons women were not contemplated as subjects for the investigation. It was felt to be highly probable that there would be considerable difficulty in getting even a sufficient number of men to submit voluntarily to the necessary procedure.

Having regard to various possibilities, I considered that the Naval Dockyard in Malta, which employs several thousands of Maltese, and gets over the difficulty of a frequently-recurring identity of name by allotting to each man a number, offered the best field for this inquiry. I accordingly obtained from Admiral Bromley, the Admiral-Superintendent of the Dockyard, an authority to proceed as I proposed. It was arranged that the various heads of departments should send batches of men, told off without discrimination, to the Dockyard Surgery on days to be arranged between us for the purpose of having samples of their blood taken for the ascertaining of agglutination reaction.

With the most cordially rendered assistance of Fleet-Surgeon Hardie, R.N., and Surgeon Westcott, R.N., I was able to obtain specimens of blood in capillary tubes from 525 dockyard employés. Each tube had a flag label attached to it bearing the man's name and dockyard number, and corresponding lists of names and numbers were prepared as the men came up to have their fingers pricked. I next proceeded to examine these 525 samples of blood for agglutination reaction to *Micrococcus melitensis*, using a dilution of 1/30 of each for that purpose. This was a somewhat laborious undertaking, and my thanks are due to Major Horrocks and Captain Kennedy, who very kindly examined between them some 140 of the whole number of samples.

As the result of this preliminary examination it was found that 79 out of the 525, or 15 per cent., gave a distinct agglutination reaction with *Micrococcus melitensis*. Of these 79, a marked reaction was presented by 22, which were accordingly selected for a detailed bacteriological examination of both the blood and urine of the men on the following conditions.

Blood.—Bend of elbow sterilised, 5 c.c. of blood taken from median basilic vein and placed in 80 c.c. of nutrient broth in a flask, this well shaken and placed in incubator at 37° C., daily agitated; sub-cultures made on to agar slopes on 6th and on 11th days. If no result appeared on 14th day, the investigation was abandoned as unfruitful; if a growth appeared, it was put through the usual tests for *Micrococcus melitensis*, and the result recorded. Blood was not taken more than once in each case, owing to the dislike of the subject to the operation.

Urine.—A supply of sterilised test-tubes was daily sent to the Dockyard surgery; the men selected were told to call there each morning at 7 A.M. on entering the dockyard to commence their work. The surgery attendants were instructed (1) to see that each man cleansed the meatus urinarius and glans with 1 in 40 carbolic solution, and (2) to collect the first 1 oz. of urine passed in a suitable vessel for rejection, and the second 1 oz. in one of the sterilised test-tubes, which was then inscribed with the man's number and the date. The samples thus obtained were to be sent to me in the laboratory, where I immediately proceeded to plate each out. From each daily sample of urine two Petri dishes containing nutrose litmus agar (no glucose), of a reaction +10, were inoculated, 1/3 of a c.c. (six drops, about) being distributed over the surface of each with a spreader. These plates were numbered, dated, and incubated at 37° C. for six days. They were then examined and the likely colonies were put through the usual tests for *Micrococcus melitensis*. Where, as in Cases IX and XI, the colonies of this organism were too numerous to be counted individually, the numbers given were arrived at by selecting an average area, counting the colonies contained in 1 sq. cm. of this, and determining the total number of square centimetres covered with colonies. The urines were thus daily examined for 28 successive days, exclusive of Sundays.

I will now describe these 22 cases as briefly as possible. The temperatures given are those of each man for the first few days of the observations, the first being the morning and the second the evening temperature. All these men were in full work for the whole period of these observations, with the exception of Case I, who was at home once for three days on the sick list. For the temperatures and brief details of each case, my thanks are due to Fleet-Surgeon Hardie, R.N., of H.M. Dockyard at Malta, who tells me that he found it impossible to ascertain definitely what kind of fever it was which some of these men say they had previously had.

Case I.—G. Araci, 4112, age 25, labourer. Had a week's fever about 12 months ago.

Temperatures.—99°/99°·2; 98°·6/99°·4; 99°/99°·8; 99°·2/99°·6; away 3 days; 99°/99°·2.

Blood yielded no *Micrococcus melitensis.*

Urine yielded 3 colonies of *Micrococcus melitensis* on July 4.
2 ,, ,, ,, ,, 12.
23 ,, ,, ,, ,, 19.
3 ,, ,, ,, ,, 21.

Case II.—G. Busutil, 1918, age 17, boiler-maker's apprentice. Had fever 13 years ago.

Temperatures. — 98°/99°; 98°·4/99°; 98°·6/98°·2; 98°/98°·8; 98°·4/98°·6; 98°/98°·4; 98°·2/98°·4.

Blood yielded no *Micrococcus melitensis.*

Urine ,, ,, ,,

Case III.—G. Ciantar, 3528, aged 38, joiner. Was sick for 2 days 2 months ago.

Temperatures.—99°·8/100°; 99°·6/99°·8; 98°·4/98°·2; 98°·0/98°·8; 98°·0/98°·4; 98°·4/98°·6; 98°·2/98°·4.

Blood yielded *Micrococcus melitensis.*

Urine yielded 1 colony of this organism on July 6.
3 colonies of ,, 7.
5 ,, ,, 8.
3 ,, ,, 13.
10 ,, ,, 15.
3 ,, ,, 17.
5 ,, ,, 18.
10 ,, ,, 19.
6 ,, ,, 21.
1 colony ,, ,, 24.

Case IV.—F. Darmanin, 4221, age 30, hammerman. Had fever 12 years ago.

Temperatures.—99°·8/99°·4; 99°·6/99°·2; 98°·6/98°·0; 98°·2/98°·6; 98°·4/98°·4; 98°·0/98°·2; 98°·2/98°·4.

Blood yielded no *Micrococcus melitensis.*

Urine yielded 3 colonies of *Micrococcus melitensis* on July 14.
1 colony of ,, 21.
9 colonies of ,, 24.

Case V.—C. Cassar, 1203, age 28, assistant fitter. Has had headaches and giddiness for the last 3 months.

Temperatures. — 99°·0/99°·0 ; 98°·0/98°·2 ; 98°/98° ; 98°·0/98°·2 ; 98°·0/98°·2 ; 98°·2/98°·4 ; 98°·0/98°·4.

Blood yielded no *Micrococcus melitensis.*

Urine ,, ,,

Case VI.—T. Sceberras, 3475, age 35, joiner. Had fever in April and May last.

Temperatures. — 99°/99° ; 98°·6/99°·0 ; 98°·4/98°·2 ; 98°·0/98°·6 ; 98°/99° ; 98°/98° ; 98°·6/98°·2.

Blood yielded no *Micrococcus melitensis.*

Urine ,, ,,

Case VII.—F. Grima, 1686, age 50, founder. No history of fever. Complains of "general debility."

Temperatures. — 100°/101°·2 ; 99°·4/99°·4 ; 99°/98° ; 98°/98° ; 98°·4/98°·0 ; 98°/98° ; 99°·2/100°.

Blood contained *Micrococcus melitensis.*

Urine yielded 9 colonies of *Micrococcus melitensis* on July 11.
1 colony ,, ,, 12.
1 ,, ,, 15.
2 colonies ,, ,, 20.
13 ,, ,, 21.
3 ,, ,, 25.

Case VIII.—D. Burlo, 1094, age 21, assistant fitter. Had "fever," lasting 15 days 2 years ago.

Temperatures.—98°·0/98°·8 ; 99°·0/98°·6 ; 98°·6/98°·2 ; 98°·4/98°·6 ; 99°·2/98°·0 ; 98°·2/98°·2 ; 98°/98°.

Blood yielded no *Micrococcus melitensis.*

Urine ,, ,,

Case IX.—B. Worley, 1857, age 29, boilermaker. Had fever 10 months ago.

Temperatures.—98°·0/98°·4 ; 98°·0/98°·4 ; 98°·2/98°·6 ; 98°·0/98°·8 ; 98°·4/98°·4 ; 98°·0/98°·4 ; 98°·0/98°·2.

Blood yielded no *Micrococcus melitensis.*

Urine contained *Micrococcus melitensis* every day from July 3 to end of August, usually in very large quantity. It was then arranged to examine it twice weekly ; it has been present on every occasion up to date of writing (November 21). The periodical examination is still being continued. Enumerations of the colonies were made on following dates in the manner described :—

July 5, 26,631 colonies of *Micrococcus melitensis* per c.c. urine.
7, 57 ,, ,,
10, 16,023 ,, ,,
14, 24 ,, ,,
22, 22,869 ,, ,,

July 24,	32,319	colonies of *Micrococcus melitensis*	per c.c. urine.
August 9,	9,450	,,	,,
14,	69	,,	,,
26,	381	,,	,,
September 29,	690	,,	,,
October 10,	9,005	,,	,,

This man's urine has been used for various feeding and other experiments with monkeys and goats by both Major Horrocks and myself, and has infected both these species of animal.

Case X.—V. Borg, 3567, age 34, tailor. Had "fever" for 3 weeks about 10 or 11 months ago.

Temperatures.—99°·0/98°·4; 98°·8/99°·2; 99°·2/98°·8; 98°·6/99°·2; 99°·0/98°·4; 98°·0/98°·2; 98°·4/98°·4.

Blood did not yield *Micrococcus melitensis.*

Urine ,, ,,

Case XI.—F. Mallia, 3414, age 31, joiner. Had fever for 4 weeks, commencing May 1, 1905.

Temperatures.—98°·8/99°·0; 98°·6/98°·6; 98°·4/98°·4; 98°·6/98°·0; 98°·2/98°·4; 98°·6/98°·4; 98°·6/98°·2.

Blood contained *Micrococcus melitensis.*

Urine contained this organism every day from July 3 to end of August. During September and October it was plated twice weekly, and only failed to yield *Micrococcus melitensis* on one occasion (September 12), when the plates were bad. The number of colonies per cubic centimetre of urine have not been so numerous as in Case IX, but have varied within wider limits as follows :—

July 3,	39	colonies of *Micrococcus melitensis*	per c.c. urine.
11,	291	,,	,,
13,	981	,,	,,
22,	108	,,	,,
24,	1,953	,,	,,
August 16,	6,426	,,	,,
25,	270	,,	,,
September 29,	13,380	,,	,,
October 18,	1,017	,,	,,

This man's urine also has been used for various successful animal infection experiments (q.v.), and up to date of writing (November 21) has continued to yield *Micrococcus melitensis* from each of the bi-weekly samples.

Case XII.—G. Saccett, 3326, age 15, rivet boy. Had 2 days' illness with headaches 4 months ago.

Temperatures.—98°·8/99°·0; 98°·4/99°·2; 98°·4/98°·6; 98°·2/98°·2; 98°·2/98°·4; 98°/98°; 98°·2/98°·4.

Blood did not yield *Micrococcus melitensis.*
Urine ” ”

CASE XIII.—G. Bianco, 2565, age 46, shipwright. Four years ago had fever for 2 months followed by arthritis.

Temperatures.—98°·6/98°·4; 98°·6/98°·4; 99°·0/98°·6; 98°·0/98°·8; 98°·0/99°·0; 98°·2/98°·0; 98°·0/98°·2.

Blood did not yield *Micrococcus melitensis.*
Urine ” ”

CASE XIV.—G. Cutajar, 3046, age 27, shipwright. States he has never had fever.

Temperatures.—99°·8/99°·2; 98°·0/99°·2; 98°·8/99°·0; 98°·4/98°·4; 98°·2/99°·0; 98°·4/98°·2; 98°·2/99°·0.

Blood did not yield *Micrococcus melitensis.*
Urine ” ”

CASE XV.—G. de Giovanni, 3022, age 27, shipwright. Three years ago had fever for about 3 weeks.

Temperatures. — 98°·4/98°·4; 98°·0/98°·4; 98°/99°; 98°·4/98°·6; 98°/99°; 98°·2/98°·8; 98°·0/98°·4.

Blood did not yield *Micrococcus melitensis.*
Urine ” ”

CASE XVI.—G. Parlar, 3797, age 16, rivet boy. Had slight fever 8 months ago.

Temperatures.—98°·2/99°·0; 98°·6/98°·6; 98°·0/98°·8; 98°·0/99°·2; 98°·0/98°·6; 98°·2/98°·2; 98°/98°.

Blood did not yield *Micrococcus melitensis.*

Urine yielded 2 colonies of *Micrococcus melitensis* on August 3.
2 ” ” 8.
5 ” ” 14.
7 ” ” 26.

CASE XVII.—Carmelo de Celis, 3796, age 15, rivet boy. Had 10 days' fever a fortnight ago.

Temperatures.—98°·4/100°·4; 98°·2/99°·8; 98°·6/99°·2; 99°·0/99°·8; 98°·8/100°; 98°·4/99°·2; 98°·0/99°·4.

Blood contained *Micrococcus melitensis.*

Urine did not yield this organism.

CASE XVIII.—E. Casinguena, 2911, age 33, shipwright. Had 10 weeks' fever 14 months ago.

Temperatures.—98°/98°; 98°·2/98°·4; 98°/98°; 98°·2/98°·4; 98°/98°; 98°·2/98°·6; 98°·0/98°·4.

Blood did not contain *Micrococcus melitensis.*

Urine yielded 1 colony of *Micrococcus melitensis* on August 4.
5 colonies ” ” 10.
2 ” ” 16.
3 ” ” 19.

Case XIX.—A. Ghirsci, 3111, age 40, shipwright. Never had fever.

Temperatures. — 98°/98° ; 98°·0/98°·4 ; 98°·0/98°·8 ; 98°·6/98°·4 ; 98°·0/98°·8 ; 98°/98° ; 98°·4/98°·6.

Blood did not yield *Micrococcus melitensis.*

Urine ,, ,,

Case XX.—R. Mamo, 906, age 32, assistant fitter. Had fever 2 years ago for 3 months.

Temperatures. — 98°·0/98°·8 ; 98°·0/98°·4 ; 98°/98° ; 98°·2/98°·6 ; 98°·4/98°·2 ; 98°·0/98°·6 ; 98°·2/98°·4.

Blood did not yield *Micrococcus melitensis.*

Urine yielded 3 colonies of *Micrococcus melitensis* on August 8.
2 ,, ,, 12.
8 ,, ,, 18.

Case XXI.—E. Agius, 2550, age 58, shipwright. Never had fever.

Temperatures. — 99°/99° ; 99°·0/99°·4 ; 99°·8/99°·2 ; 98°·8/99°·6 ; 98°·4/99°·2 ; 98°·6/98°·4 ; 98°·4/98°·6.

Blood did not yield *Micrococcus melitensis.*

Urine ,, ,,

Case XXII.—A. Gatt, 3625, age 49, painter. Had slight fever for about 4 days 2 years ago.

Temperatures. — 99°/99° ; 98°·4/99°·6 ; 98°·4/99°·2 ; 98°·8/99°·0 ; 98°·4/99°·0 ; 98°·8/99°·2 ; 98°·4/98°·4.

Blood did not yield *Micrococcus melitensis.*

Urine ,, ,,

Results.—Thus all 22 of these cases gave a marked agglutination reaction with *Micrococcus melitensis.* From three of them (Cases III, VII, and XI) the parasite was recovered from both blood and urine. From one it was obtained from the blood only (Case XVII), and from six (Cases I, IV, IX, XVI, XVIII, and XX) from the urine only. All these men were up and about and in full work during the period of observation.

Though all these men presented such a marked agglutination reaction as to make it a certainty, they had all had Malta Fever some time or other ; Cases VII, XIV, XIX, and XXI deny ever having had it at all, although from Case VII *Micrococcus melitensis* was recovered from both blood and urine. As regards temperatures, it will be seen there was a slight rise above the normal in three of the four (III, VII and XVII), from whose blood the *Micrococcus melitensis* was recovered ; that of the fourth (Case XI) being practically continuously normal. While of those six from whom the urine alone yielded the parasite, the temperatures of two (Cases I and IV) were slightly raised, those of the remaining four (Cases IX, XVI, XVIII and XX) being practically normal. The infectivity of the urines of these cases is shown by the fact that a few cubic centimetres of the urine of No. 9, injected subcutaneously into a monkey, gave rise to a typical attack of Malta Fever, with recovery of *Micrococcus melitensis* from the blood and organs, and also by the successful feeding experiments on both monkeys and goats (q.v.) which were carried on separately by Major Horrocks and myself with the urines of Cases IX and XI, which excreted *Micrococcus melitensis* on a remarkable scale both in regard to amount and duration.

Conclusions 1.—That the existence of ambulatory cases is now proved.
2.—That their urine contains *Micrococcus melitensis*, in large quantity and for prolonged periods, is proved.
3.—That their urine is a source of infection, at least to monkeys and goats, is proved.

III. MEDITERRANEAN FEVER IN GOATS, COWS, AND OTHER ANIMALS.

By Staff-Surgeon E. A. Shaw, R.N.

(Received November 25, 1905.)

I. Goats.

A.—*Experimental.*

To determine experimentally to what degree goats, which are so numerous in Malta, are susceptible to Malta Fever, I determined, in July, 1904, to inject cultures of *Micrococcus melitensis* subcutaneously into these animals. Thinking that possibly there might be a difference of susceptibility between the mature and immature animal, I began with experiments on a goat and a kid. On July 30, 1904, a female goat, two years old, and a female kid, three months old, were purchased, their blood was examined for agglutination reaction to *Micrococcus melitensis* (which was found to be nil), and they were kept under observation for a week. They were then dealt with as follows:—*

Experiment 1.—Goat ♀. July 30, 1904, no agglutination reaction; temperature normal, practically between 101° and 102° F. till August 8, 1904. Injected subcutaneously at noon of that day into left flank an emulsion of the six-day growth of *Micrococcus melitensis* on six agar slopes, second generation from spleen of human fatal case. This caused a rise of temperature of 3°·8 F., from 102° to 105°·9 F. on the 9th, and 107°·2 on the 10th of August, then gradually falling back to normal by August 14.

Agglutination.—Agglutination reaction was first present on August 13, 1 in 30; rising to 1 in 200 on August 14, and 1 in 1800 on August 20, on which date the goat received a second injection of the growth from four similar agar slopes of *Micrococcus melitensis*, which caused a similar rise of temperature for three days. On August 29 it received a third injection of emulsified growth from four more slopes. On August 30 the agglutination reaction was 1 in 2200, and on September 5, 1 in 3200. All these were visible under $\frac{2}{3}$-in. objective in 15 minutes.

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* [It should be stated that the first of these experiments was briefly described by the author in the manuscript of the Report by him published in the first Part of the Reports of this Commission (March, 1905), but the paragraph was deleted at his request, as the observations were, in his opinion, still incomplete, though he recognised and stated that the "goats, which are extremely numerous in Malta, might possibly be instrumental in transmitting the infection of Malta Fever."—Sec. R.S.]

Urine.—This was plated daily, after having been drawn off into a sterile vessel by a sterile catheter, which I passed myself from August 25 to September 6, ½ c.c. of urine being distributed over the surface of glucose nutrose litmus agar contained in Petri dishes, which were incubated for six days at 37° C. On September 6, 1904, I went on three weeks' leave. On my return experiments were resumed by me on September 30. A fourth subcutaneous injection of *Micrococcus melitensis* growth from six agar slopes as before was made on October 10, with the idea of giving the goats' kidneys plenty of the parasite to excrete. The experiment was continued till October 31 and was then given up, no *Micrococcus melitensis* having been at any time recovered from the urine of this animal.

Milk.—This was first plated for recovery of possible *Micrococcus melitensis* on August 28, 1904; but on September 1 the plates were found to be completely overgrown with a *Staphylococcus*, and on centrifugalising the milk from each udder and making film preparations from the deposit, I recognised pus in the milk from each udder. On August 28 also, feeding experiments with the milk of this goat were commenced on a healthy monkey (No. 61), a stomach tube being passed and 1 oz. given on this date, 2 ozs. on August 29, 4 ozs. on the 30th, and 4 ozs. on the 31st; but such severe diarrhœa was developed that no more milk was given after the last date. This monkey, unfortunately, succumbed on September 4. The usual inoculations were made from its organs and heart's blood into broth, and on to agar slopes, but no *Micrococcus melitensis* was recovered. The milk of this goat was examined from time to time, but the pus persisted till April 25, 1905, by which time the milk was "drying up." It may be noticed in passing that suppurative mastitis is by no means infrequent amongst goats in Malta and causes, from time to time, outbreaks of illness amongst children (see *Health Reports of Malta*). In June, 1905, the secretion of milk had practically ceased and pus was no longer present in the altered secretion, now thick, ropy, brownish and gelatinous; which, on being plated on June 24, yielded colonies of *Micrococcus melitensis* in abundance.*

Blood.—The agglutination reaction continued to increase, being 1 in 3200 on September 30, 1904, and 1 in 4500 on October 18. It then began to diminish, being 1 in 3000 on November 1, 1904, 1 in 3000 on January 3, 1905, 1 in 3000 on February 27, 1905, and after this stationary period going down to 1 in 2000 on April 25, 1905, and 1 in 1500 on June 12, 1905.

Micrococcus melitensis was recovered from the blood (5 c.c.) of the jugular vein on November 7, 1904, and again from the blood of the same vein on June 27, 1905.

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* [Major Horrocks had previously recovered *Micrococcus melitensis* from apparently normal goats, and had shown the plates to Staff-Surgeon Shaw.—Sec. R.S.]

Experiment 2.—Goat, juv. The kid of three months, purchased at the same time as the goat, received injections of *Micrococcus melitensis* on the same dates as the goat, but only in half the quantities.

Its urine was plated on the same days above detailed for the goat but it never yielded any *Micrococcus melitensis*. Its agglutination reaction was similarly examined with the following results:—

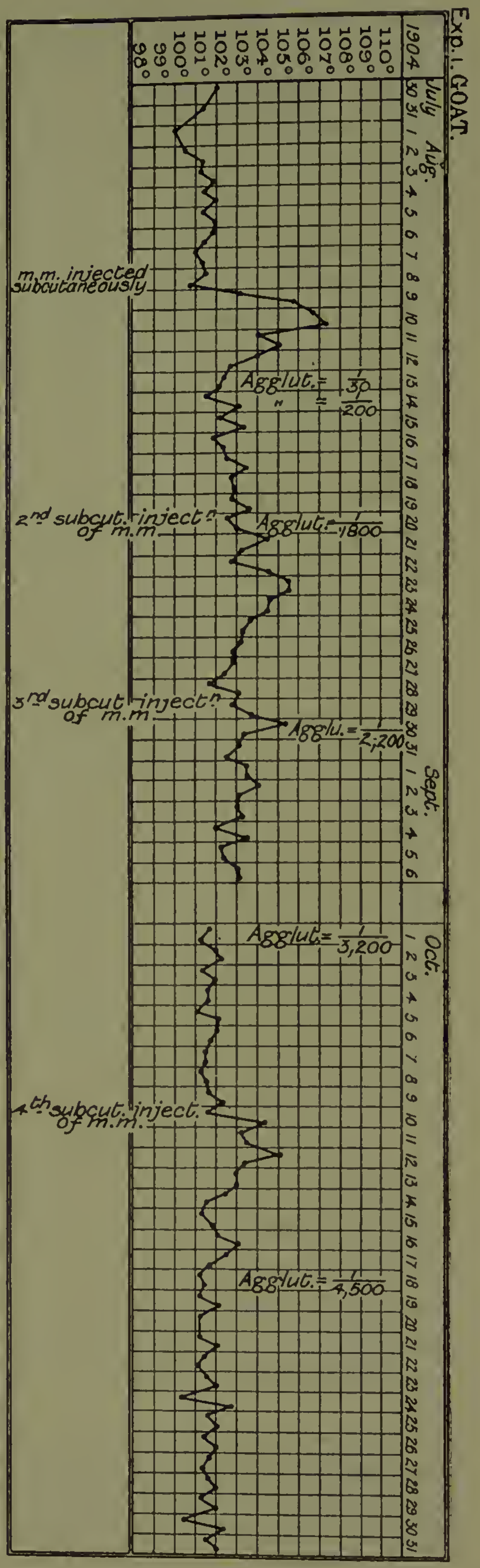
1904—		
July	30	Nil
August	14	1/200
,,	20	1/200
,,	30	1/1800
September	5	1/3200
,,	30	1/3200
October	11	1/5500
,,	18	1/5000
,,	25	1/2000
November	1	1/3000
1905—		
January	3	1/2000
February	27	1/1500
April	25	1/1500

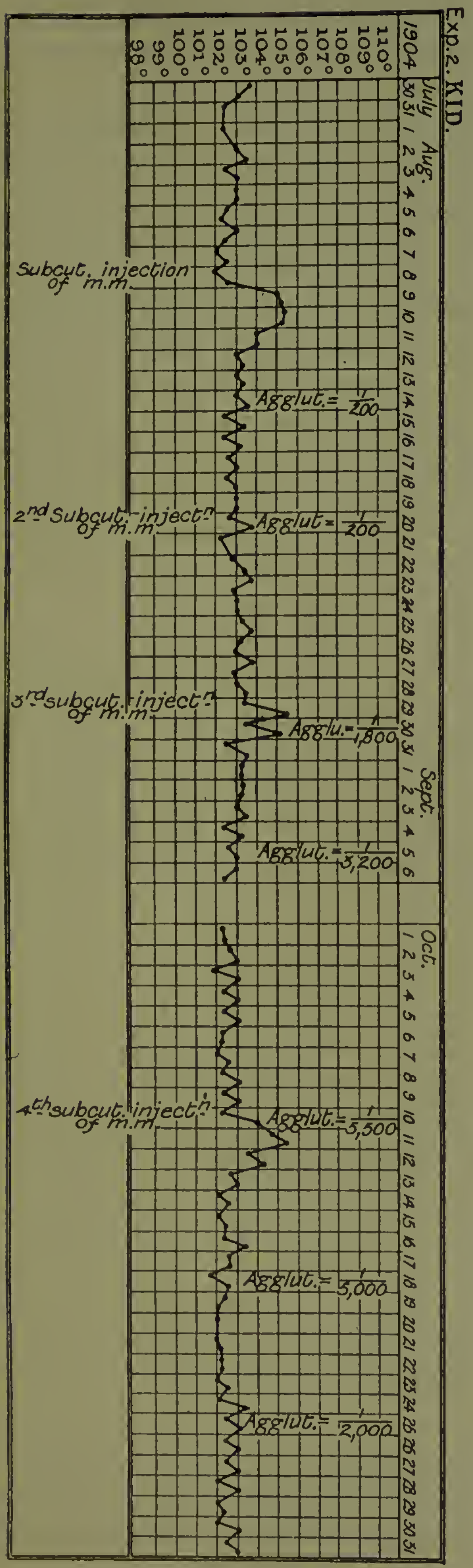
These figures follow closely those obtained from the goat, but rise somewhat higher in degree. *Micrococcus melitensis* was recovered from the blood of the kid in November, 1904, and in June, 1905.

From an inspection of the accompanying charts it will be seen that the rise of temperature following each injection is only temporary, lasting but three or four days, thus decidedly differing from the prolonged wave of fever produced in monkeys by a similar procedure, and suggesting a sort of racial tolerance of this infection on the part of the Maltese goat. It was thus proved by the development of a high agglutination reaction in August, 1904, and by the recovery of living *Micrococcus melitensis* from the blood in November, 1904, that the goat is at least experimentally susceptible to Mediterranean Fever.

B. *Natural.*

Dr. Zammit in June, 1905, found that the blood of four goats (out of six purchased for further experimentation) reacted to *Micrococcus melitensis* at the time of purchase. This observation having been confirmed by Major Horrocks and myself, and the micro-organism having also been recovered from the milk of one of these animals, the question of the agency of the goat in diffusing the *Micrococcus melitensis* was brought from the domain of speculative experiment


Exp. 1. GOAT.


Exp. 2. KID.

into the range of everyday life.* And after discussing the matter with Deputy Inspector-General Bentham, of the Naval Hospital at Bighi, we decided that I should at once begin an examination of all the goats supplying milk to this hospital.

The method of procedure adopted was as follows:—The goats were taken in batches of 12 to 16 at a time. The milk contractor's son took down in Maltese the name and description of each goat, which was numbered. A little blood was taken from the goat's ear in a capillary tube for examination for agglutination, and at the same time 40 to 50 c.c. of milk were drawn off into a sterile test-tube; to both of these the same number was attached, the intention being to subsequently eliminate all the goats which might be found infected. After examination of the blood for agglutination reaction, the milk of each goat which reacted was centrifugalised, and the centrifuged portion was plated on nutrose-litmus-agar, $\frac{1}{4}$ c.c. being distributed over the surface of each Petri dish. These were incubated at 37° C., and were then examined for *Micrococcus melitensis* colonies in the usual way. Four to six plates were used for each milk thus treated.

The examination was begun on June 29. Surgeon Whiteside, R.N., was so good as to collect the necessary material from the goats at times when I was unable to attend, and he also helped with the agglutination reactions. These were done in two stages, the first to eliminate the non-agglutinating bloods (or milks), the second to determine highest dilution giving agglutination of the remainder. All went well for a few days, until the goat-herds, who had all along looked unhappy over the pricking of their goats' ears for blood, broke out into open rebellion, and henceforth we had to be content with only milk. This necessitated either plating every milk or ascertaining the existence of the agglutination reaction with it. I have already mentioned the excretion of agglutinins in the urine (Part III of these reports, p. 47). It seemed not unlikely that they would be found to be present in the milk of infected animals. I accordingly put up specimens of such milk, centrifuged and uncentrifuged, diluted and undiluted, with freshly prepared emulsion of *Micrococcus melitensis* in drops on slides in a moist chamber, with controls of normal milk, and left them for an hour. I then examined them under the microscope and found distinct agglutinations with the infected milks; most palpably in the uncentrifuged specimens, the appearance in the centrifuged series being somewhat masked by *débris* of various sorts.

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* Major Horrocks states that Dr. Zammit and he found that five of the normal goats reacted, and that he recovered *Micrococcus melitensis* from the milk of all of them but one. He remarks, further, that "the fact that the milk of infected goats causes agglutination of the *Micrococcus melitensis* was first shown by Zammit, and in the combined paper by Kennedy and myself the reaction is called Zammit's test." —[Sec. R.S.]

When the milk was allowed to stand in the sterile test-tubes for a couple of hours, a considerable layer of cream came to the top and a deposit of *débris* gathered at the bottom. By passing a pipette down to the middle of the column, aspirating milk from there, withdrawing the pipette and then breaking off the capillary end of the pipette well above the adherent cream, I could obtain a specimen of milk almost free from *débris* and with relatively few oil globules, in which the presence or absence of agglutination was fairly easily determinable. This method was, therefore, perforce adopted for the ascertaining of agglutination reaction in the batches of goats examined on July 13 and 14, a 24-hour limit for contact of diluted milk and emulsion being adopted for determination of highest dilution giving agglutination.

The details of these examinations of the goats supplying milk to Bighi Hospital in June and July, 1905, are subjoined.

June 29. Twelve goats examined. Agglutination reaction found in blood of three: No. 4, in a dilution of 1 in 30; No. 8, 1 in 100; No. 10, 1 in 60. Milks of all three centrifugalised, plated, and incubated. *Micrococcus melitensis* recovered and verified from No. 8 only (49 colonies).

July 3. Second batch of 12 goats examined. Agglutination reaction found in blood of five: No. 4, 1 in 100; No. 5, 1 in 60; No. 6, 1 in 60; No. 8, 1 in 30; No. 9, 1 in 30. Milks of all these five centrifugalised, plated, and incubated. *Micrococcus melitensis* recovered and verified from No. 5 (38 colonies), and No. 6 (728 colonies).

July 6. Third batch of 16 goats examined. Agglutination reaction found in blood of three: No. 1, 1 in 100; No. 3, 1 in 60; No. 14, 1 in 160. Milks of these three centrifugalised, plated, and incubated. *Micrococcus melitensis* recovered and verified from No. 3 (six colonies).

July 7. Fourth batch of 12 goats examined. Agglutination reaction found in blood of three: No. 5, 1 in 30; No. 7, 1 in 30; No. 10, 1 in 30. Milks of these three centrifugalised, plated, and incubated. No *Micrococcus melitensis* recovered from any.

July 10. Fifth batch of 12 goats examined. Agglutination-reaction found in blood of six: No. 1, 1 in 60; No. 5, 1 in 200; No. 7, 1 in 200; No. 8, 1 in 60; No. 9, 1 in 60. Milks of these six centrifugalised, plated, and incubated. *Micrococcus melitensis* recovered and verified from No. 1 (10 colonies) and from No. 7 (seven colonies).

July 13. Sixth batch of 15 goats examined. Agglutination reaction found in milk of four: No. 2, 1 in 100 after 24 hours' contact in moist chamber; No. 11, 1 in 60; No. 14, 1 in 30; and No. 15, 1 in 30, all under the same conditions. Milks of these four centrifugalised, plated, and incubated. *Micrococcus melitensis* recovered from No. 2 (15 colonies) and No. 11 (five colonies).

July 14. Seventh batch of 12 goats examined. Agglutination reaction found in milk of six: No. 1, 1 in 150 after 24 hours' contact in moist chamber; No. 2, 1 in 160; No. 4, 1 in 30; No. 7, 1 in 30; No. 9, 1 in 30; No. 12, 1 in 30. *Micrococcus melitensis* was recovered and verified only from No. 4 (two colonies).

For convenience of reference, these results may be arranged in tabular form, thus:—

Date.	No. of goats examined.	No. presenting agglutination reaction.	Distinguishing No. of the goats of each batch whose milk yielded *Micrococcus melitensis*.	Agglutination limit of latter.	No. of *Micrococcus melitensis* colonies recovered.
29 June...	12	3	No. 8	1 in 100	49
3 July ...	12	5	No. 5	1 ,, 60	38
			No. 6	1 ,, 60	728
6 ,, ...	16	3	No. 3	1 ,, 60	6
7 ,, ...	12	3	None	—	—
10 ,, ...	12	6	No. 1	1 in 60	10
			No. 7	1 ,, 200	7
13 ,, ...	15	4	No. 2	1 ,, 100	15
			No. 11	1 ,, 60	5
14 ,, ...	12	6	No. 4	1 ,, 30	2
Totals...	91	30	9	—	—

Thus 91 goats were examined, of these, 30 presented the agglutinating reaction on *Micrococcus melitensis*, and the milk of these 30 was examined culturally for the parasite, this organism being recovered from the milk of nine of them. The implicated animals were eliminated from the herds supplying the Naval Hospital, and the most stringent measures were taken to ensure that all milk entering the hospital gates was forthwith boiled. It will be interesting to see whether any alteration takes place in the future incidence of cases of fever developing in this hospital.

It will be noticed that in these naturally-infected goats the agglutination limit is low, the highest found being 1 in 200, whereas in the experimentally infected animal it was found as high as 1 in 4500. No indication has been observed of any relation between agglutination value and the number of colonies of *Micrococcus melitensis* yielded by the milk.

The number of organisms other than *Micrococcus melitensis* found in the milk from these 30 goats varied enormously, though the milk was collected under precisely similar conditions from all. In some cases $\frac{1}{4}$ c.c. of milk would contain but two or three organisms, in others they would be present by the thousand. Time did not admit of a detailed examination being made of these.

The infectivity of the milks obtained from the goats which were the subjects of the experiments here detailed was investigated as follows:—

A monkey received from Genoa on July 12 was kept under observation for a week, its temperature was found to be normal during this period, and its blood did not react to *Micrococcus melitensis*. On July 20, the colonies of this micro-organism obtained from No. 2 goat's milk, plated July 13, were emulsified in a little normal saline solution. The monkey being held on its back, three drops of this emulsion were dropped down each nostril with a capillary pipette. The animal developed a typical attack of Mediterranean Fever, its blood gave agglutination reaction to *Micrococcus melitensis* first on August 3; 14 days after infection in a dilution of 1 in 30, running up to 1 in 320 on August 6, and 1 in 960 on August 10; *Micrococcus melitensis* was recovered from its blood during life on August 22, and from its lymphatic glands after death on October 18.

II. Cows.

As it seemed by no means impossible that cows also might be found to be infected with Mediterranean Fever, I determined to investigate this question. Not many milch cows are to be seen in the Island of Malta, there being no pasturage for them. Their owners keep them shut up, some of their stables being most scrupulously clean, while others are much the reverse. The cows seldom get outside. There is a considerable demand for their milk, especially on the part of the resident English population, many of whom dislike the taste of goat's milk, while others object to receive milk from an animal which has just previously been lying down in the street with its udders and teats in close contact with the excreta, liquid and solid, of the various animals, higher and lower.

To Mr. A. M. Macfarlane, M.R.C.V.S., Veterinary Surgeon to the Malta Government, who helped me to procure the necessary materials for bacteriological examination, my warmest thanks are due for the kindness with which he took me round to the various farms, used his influence with the owners of the cattle, and personally assisted in collecting the necessary material for examination.

The method of investigation determined on was as follows: At each of the various farms visited, blood was taken from the cows, each animal being assigned a number, which was cut deep in Roman numerals into the hair of its back. The samples of blood were correspondingly numbered, and were subsequently examined for agglutination reaction to *Micrococcus melitensis*. The numbers of the cows, at each farm, giving this reaction, were sent with a daily supply of sterilised test tubes to Mr. Macfarlane, who undertook the collection of a daily sample of milk from each of the cows specified. These milks were received at the laboratory about an hour after they were drawn. They were at once centrifugalised, and the deposit was plated on nutrose-litmus-agar in Petri dishes, three plates to each sample. These were incubated five days at 37° C., and were examined in the usual way for colonies of the micro-organism. The milks were thus treated daily from August 1 to August 24, 1905, inclusive, with the following results :—

G. F. of Tarxien.—*Nine cows*, of which three presented agglutination reaction to *Micrococcus melitensis* as follows : No. 3, 1 in 30 ; this being a heifer, no milk was attainable, and no other form of examination was permitted. No. 4 agglutinated *Micrococcus melitensis* in a dilution of 1 in 30, and No. 7 in a dilution of 1 in 60. The milks of the two latter were daily plated for 24 consecutive days. Cow No. 7 never yielded any colonies of parasite, but these were found in the milk of Cow No. 4, as follows :—

Plates of	7th	August	5	colonies of	*Micrococcus melitensis.*
,,	8th	,,	7	,,	,,
,,	12th	,,	7	,,	,,
,,	16th	,,	3	,,	,,
,,	19th	,,	40	,,	,,
,,	20th	,,	3	,,	,,
,,	21st	,,	39	,,	,,
,,	24th	,,	19	,,	,,

none being found on the other days.

F. G. of Hamrun.—*Nine cows*, of which five presented agglutination reaction as follows :—

No.	1	agglutinated	1 in 30.
,,	4	,,	1 in 800.
,,	8	,,	1 in 200.
,,	9	,,	1 in 30.

Of these Cow No. 9 was ailing and not yielding any milk. The milks of the others were plated daily. Nos. 1 and 4 never yielded any colonies of *Micrococcus melitensis*, which, however, were found in the milk of Cow No. 8, as follows :—

Plates of	11th	August,	63	colonies of	*Micrococcus melitensis.*
,,	12th	,,	9	,,	,,
,,	13th	,,	31	,,	,,
,,	16th	,,	23	,,	,,
,,	18th	,,	7	,,	,,
,,	19th	,,	13	,,	,,
,,	20th	,,	231	,,	,,

none being found on the other days.

S. G. of Hamrun.—Six cows, none of which presented any agglutination reaction.

C. G. of Hamrun.—Three cows, of which only 1 presented an agglutination reaction in a dilution of 1 in 30. The milk of this animal was daily examined, but never presented any *Micrococcus melitensis*.

C. C. of St. Julian's.—Four cows, of which No. 2 presented a high agglutination reaction, this being present in a dilution of 1 in 1000. Unfortunately this animal happened to be a heifer, so again no further material for bacteriological examination was procurable.

S. M. of Imsieral.—Two cows, neither of which presented any agglutination reaction to *Micrococcus melitensis*.

Result.—Thirty-three cows examined. Ten of these presented an agglutination reaction to *Micrococcus melitensis*, varying from 1 in 30 to 1 in 1000. From the milk of two of these cows *Micrococcus melitensis* was isolated.

III. OTHER ANIMALS.

During the months of July and August, 1905, I examined specimens of blood kindly procured for me by Mr. Macfarlane, M.R.C.V.S., from 31 bullocks which were ailing in a vague indefinite sort of way, and which he thought might possibly be infected with Malta Fever. Of these, five presented a very faint agglutination reaction. None of these animals had been in the island over three months.

I also examined several times the blood of two dogs similarly suspected. Neither of these presented any reaction to *Micrococcus melitensis*.

REMARKS.

The manner in which animals become infected with the virus of Mediterranean Fever is a matter of considerable interest and importance. Up to the present all the evidence available points to their food as being the main vehicle of infection. The feeding experiments carried on by Major Horrocks and by myself show conclusively that monkeys and goats may be thus infected. Besides the very obvious way of infection of the young through their mothers' milk, the successful result of various feeding experiments with food soiled, directly and indirectly, with the urine of two ambulatory cases of Mediterranean Fever which I discovered working in the Dockyard, and in whose urine living *Micrococcus melitensis* was being excreted, indicates another way in which these animals may be infected while feeding Goats may be seen any day in the streets of the chief city of the Island of Malta feeding on filth and rubbish of every possible variety, some of it visibly saturated with urine, animal and human. Among the lower class Maltese, as above stated, workmen have been found who void living *Micrococcus melitensis* in their urine, as do a certain number of the infected goats. Thus the path of this manner of infection becomes clear. Having satisfied their hunger in this manner, the goats lie down in the streets to digest their meal with their teats and udders often in contact with the ordure of the gutters and roads, till they are kicked up by the goat-herd to be milked into the vessel brought to the doors of the adjacent houses by their occupants. It is hence not to be wondered at that these animals frequently suffer also from suppurative mastitis, and give milk containing pus. In the Health Reports of the Malta Government may be seen reports of outbreaks of illness amongst children directly traced to this cause by their medical officers.

With regard to cows, the evidence is not quite so clear. Kept shut up in "shippens," and seldom allowed outside, they have their food brought to them, but as this food is composed of vegetable and other refuse collected from every possible source and situation, it is easy to understand that they can hardly escape from receiving infected food from time to time.

Summary.

1. The susceptibility of goats to experimental infection by *Micrococcus melitensis* was ascertained by me in the summer of 1904, and is here further demonstrated.
2. The persistence of living *Micrococci* in the blood of a goat for seven months has been proved. The bearing of this observation on the preparation of a therapeutic serum is obvious.
3. Of 91 goats in full milk, 30 were found to have become infected with Mediterranean Fever at some time or other, as shown by their agglutinating power on *Micrococcus melitensis*. Living examples of the micro-organism were recovered from the milk of nine of these, and its infectivity was demonstrated on a monkey.
4. Of 33 cows examined, 10 were found to have become infected with Mediterranean Fever, and living *Micrococcus melitensis* was recovered from the milk of two of these.
5. Of 31 bullocks examined, five were found to show a faint agglutination reaction, which may indicate that they had become infected with Malta Fever.
6. Of two ailing dogs, thought to be suffering from this fever, neither was found to be infected.

IV. ON THE DURATION OF LIFE OF THE *MICROCOCCUS MELITENSIS* IN UNSTERILISED SOIL.

By Major W. H. HORROCKS, R.A.M.C.

(Received December 16, 1905.)

In Part I of the "Reports of the Mediterranean Fever Commission," studies were described as to the duration of life of the *Micrococcus melitensis* in sterilised soils, and it was shown that not only did the organism survive in these soils, but also that it was possible to infect monkeys by causing them to inhale infected dust. These results having been obtained, it became necessary to ascertain whether the microbe could live in unsterilised dust such as is found in the streets of Malta, and also in earth fouled with excrementitious material.

Experiment I.

To ascertain the duration of life of the *Micrococcus melitensis* in dust collected from the Strada Mercanti, Malta.

On May 19 dust was collected from the street and placed in sterile test-tubes. A loopful of the dust was then added to varying quantities of water contained in sterile watch glasses. Surface plates were next made from these dilutions, and the dilution determined which produced colonies sufficiently discrete, after four days' incubation, to enable the *Micrococcus melitensis* to be detected should it be present.

On May 22 an emulsion of an agar growth of the *Micrococcus melitensis* in sterile water was added to the street dust so as to wet every particle, the tubes were then placed in the laboratory cupboard and allowed to dry naturally.

On May 27 the dilution of the soil determined above was plated on the surface of 12 glucose-litmus-nutrose-agar plates. Typical colonies, reacting to all the tests, were recovered.

On June 13 the *Micrococcus melitensis* was again isolated.

On June 19 a successful recovery was also made, but after this all attempts to isolate the microbe were unsuccessful.

Result.—The *Micrococcus melitensis* lived for 28 days in natural dust collected from the Strada Mercanti.

Experiment II.

To ascertain the duration of life of the *Micrococcus melitensis* in unsterile building dust.

This particular dust was selected as it is often polluted by the workmen during building operations, and, being very light, is easily blown about the streets.

On May 22 the dust was placed in sterile test-tubes, and then thoroughly moistened with an emulsion of an agar growth of the

Micrococcus melitensis in sterile water. As in Experiment I, trial plates were made to ascertain the quantity of soil which would produce discrete colonies on surface glucose-litmus-nutrose-agar plates.

On May 24 and 27, and on June 2, 5, 9, 13, and 19 the *Micrococcus melitensis* was isolated from the soil, but all the attempts to recover it at later dates proved unsuccessful.

Result.—The *Micrococcus melitensis* lived for 28 days in the natural building dust found in the streets of Valetta.

Experiment III.

To ascertain the duration in life in soil of a culture derived from *Micrococcus melitensis* which had assumed a saprophytic existence for some seven weeks.

It was thought that a *Micrococcus melitensis*, which had apparently become accommodated to conditions of life external to the human body, might live for a much longer period in soil than a culture directly isolated from the spleen of a Mediterranean Fever patient. Accordingly, on June 22, a culture of the microbe, which had been isolated from a sample of tap-water to which it had been added seven weeks previously, was made into an emulsion with water and then added to dust swept up from the Strada Mercanti. The same procedure was followed as in Experiment II. The *Micrococcus melitensis* was recovered on the twenty-fifth day after the commencement of the experiment, but not at a later date.

Result.—A culture of a *Micrococcus melitensis*, which had already assumed a saprophytic existence, did not appear to live longer in soil than a culture freshly isolated from the body of Mediterranean Fever patients.

Experiment IV.

To ascertain the duration of life of the *Micrococcus melitensis* in non-sterile manured garden soil.

Soil obtained from a garden which had been recently manured was placed in test-tubes, and then thoroughly wetted with an emulsion in water of an agar culture of *Micrococcus melitensis* isolated from a case of Mediterranean Fever. The same procedure was followed as in Experiments II and III, but, owing to the foul condition of the soil, it was found that only a few particles of soil could be used to make a workable dilution. The microbe was recovered five days after the inoculation was made.

Experiment V.

This was a repetition of Experiment IV. The *Micrococcus melitensis* survived for 20 days.

Having ascertained that the *Micrococcus melitensis* could live for three to four weeks in polluted soils, it appeared desirable to ascertain whether the *Micrococcus melitensis* could be recovered from a soil infected with the urine of Mediterranean Fever patients. Accordingly, a urine containing from 10,000 to 30,000 micrococci per cubic centimetre was added to building dust and to dust swept up from the Strada Mercanti, and attempts were made to isolate the specific organism by the procedure already detailed. Unfortunately, all the experiments failed, and the reason is not far to seek. Polluted soils contain from 5,000,000 to 50,000,000 microbes per gramme, and taking the urine at its richest and the soil at its lowest computation, there would be only 3 of the specific micrococci to 500 of the soil microbes. A plate containing 500 colonies is far too crowded to allow of the *Micrococcus melitensis* being isolated, as, after four days' incubation at 37° C., such a plate is completely overgrown. Further dilutions were attempted, but the *Micrococcus melitensis* could not be recovered.

Experiments were then made to ascertain the duration of life of the *Micrococcus melitensis* when a sterilised soil is infected with the urine from Mediterranean Fever patients. The same procedure was followed as in the other experiments, and the *Micrococcus melitensis* was readily isolated after 24 hours, but not at a later date. It was found that the saprophytic microbes in the urine rapidly multiplied in the soils experimented with, and after 48 hours the plates became unworkable unless a dilution of the soil, which practically precluded all hope of recovering the *Micrococcus melitensis*, was employed.

Experiments made to Determine whether it is possible to Infect Animals with Dust Polluted by Urine of Mediterranean Fever Patients.

In the Report of the Commission, Part I, experiments were related which showed that monkeys could be infected by dust artificially inoculated with large quantities of the *Micrococcus melitensis*, and in view of the "dust theory" in relation to the question of the infection of human beings, it appeared important to repeat the experiments, using, however, a dust infected with urine containing the *Micrococcus melitensis.* Such experiments would be the nearest approach that could be made to the conditions actually occurring in Nature.

Experiment I.—Infected Dust blown into the Throat and added to Food.

Monkey No. 111 was kept under observation for some 14 days, and its temperature taken morning and evening. Its blood was also repeatedly examined for reaction with the *Micrococcus melitensis.* The animal appearing perfectly well, the experiment was commenced on July 21, when dust from the Strada Mercanti, infected with urine from Case No. XI (Shaw), and then dried for four days at 37° C., was blown into the pharynx. On the next day a little of the dust was mixed with a feed of boiled rice. The same procedure was followed until August 9, when, no trace of infection having appeared, it was determined to dry the dust for only 24 hours at 37° C., as it was thought that the prolonged drying in the incubator might have destroyed the virulence of the microbe. On August 13 artificially dried dust was discarded, and dust dried naturally at the room temperature employed. On August 18 the monkey was seized with an acute attack of diarrhœa, and died on the 22nd. At the *post-mortem* examination nothing abnormal was noticed. Cultures were made from the spleen, liver, kidneys, heart's blood, mesenteric, femoral, and axillary glands. All the cultures, however, proved to be sterile.

Experiment II.—Infected Dust blown in the Nostril.

Monkey No. 112 was kept under observation and examined as in the previous experiment. On July 22 sterile building dust, infected with urine of Case XI, and dried artificially, was injected into the nostril. The same dust was injected daily until July 26, when a dust infected with the mixed urine of Cases IX and XI was employed. The injection of this dust once a day having also failed to produce any sign of infection, on August 9 a dust dried at the laboratory temperature was used. On August 23 the monkey appeared very ill, and refused his food; there was, however, no fever, and the blood showed no signs of a reaction with the *Micrococcus melitensis.* The dust injections were discontinued, and the monkey slowly improved, but he never regained his former sleek appearance.

On October 15 the blood diluted 1/10 gave a positive reaction.

On October 18 severe dropsy developed, and the monkey, being seriously ill, was killed with chloroform. Nothing abnormal was found at the *post-mortem* examination. Cultures were made from the spleen, liver, kidneys, bile, blood, and glands, but no signs of the *Micrococcus melitensis* were discovered.

Experiment III.—Infected Dry Dust added to Food.

Monkey No. 113 was kept under observation for a fortnight, and its blood was repeatedly tested as to agglutination with the *Micrococcus melitensis.* On July 24 dust infected with urine of Case XI, and dried naturally for four days, was added to the food.

On July 26 dust infected with the mixed urine of Cases IX and XI was added to the food. The feeding was continued daily until August 6, when the monkey was seized with violent vomiting and diarrhœa, and died on the following morning. During the experiment the blood was repeatedly examined, but never showed the slightest trace of a reaction with the *Micrococcus melitensis.* At the *post-mortem* examination fluid was found in the peritoneum and pericardium; the liver, spleen, and kidneys appeared congested. Cultures were made from the spleen, liver, kidneys, bile, heart's blood, and glands. No signs of the *Micrococcus melitensis* were detected.

Experiment IV.—Infected Dry Dust added to Food.

Monkey No. 114 was used for this experiment, preliminary observation having shown that it was perfectly healthy. On July 24 dust infected with the urine of Case XI, and dried naturally for 10 days, was added to the food. The feeding was continued daily until August 9, when, owing to the high external temperature, it was found possible to dry the soil in 24 hours. Feeding with this soil was continued until September 17. The blood was examined weekly from the commencement of the feeding, but never showed the slightest trace of a reaction with the *Micrococcus melitensis*. The monkey is still under observation, and appears in perfect health.

Remarks.—Though the attempts to infect monkeys with dust polluted with urine from a case of Mediterranean Fever have failed, the histories of Goats Nos. 13 and 14 show that it is possible to infect these animals in this manner. The ingestion of polluted soils gave rise to violent vomiting and diarrhœa in the case of the three out of the four monkeys experimented upon, and this disturbance of the digestive tract may possibly account for the failure of the experiments. Monkey No. 114 may have been insusceptible. Monkeys vary considerably in their susceptibility to infection; No. 110, mentioned in later experiments, could not be infected, though it received the growth on an agar slope subcutaneously on six separate occasions.

Summary.

1. The *Micrococcus melitensis* survived for 28 days in natural dust collected from the Strada Mercanti, Malta.
2. The *Micrococcus melitensis* survived for 28 days in the natural building dust found in the streets of Valletta, Malta.
3. A sub-culture from a *Micrococcus melitensis*, which had assumed a saprophytic existence for several weeks in water, did not appear to live longer in soil than a culture freshly isolated from the body of a Mediterranean Fever patient.
4. The *Micrococcus melitensis* survived for 20 days in an unsterilised manured garden soil.
5. It has not been found possible to infect monkeys with dust polluted with urine from Mediterranean Fever patients and then thoroughly dried. Goats, however, can be infected in this manner.

V. CONTACT EXPERIMENTS.

By Major W. H. Horrocks, R.A.M.C.

(Received December 16, 1905.)

In the first report of the Mediterranean Fever Commission a description was given of an experiment in which a healthy monkey living between two infected monkeys became infected with the *Micrococcus melitensis*.

The infection might have occurred in the following ways, *i.e.*, (*a*) by direct skin contact; (*b*) by placing in its mouth paws fouled with urine excreted by its neighbours; (*c*) by means of mosquitoes; (*d*) by ecto-parasites passing from the skin of the infected monkeys to the healthy monkey.

Experiments were devised in order to ascertain which of the above possible causes had produced the infection. In the first experiment a healthy monkey was placed in a box next to infected monkeys, and the boxes were surrounded by mosquito-proof netting. The monkeys were in intimate contact, and the boxes were frequently changed, the healthy monkey being allowed to live for a few days at a time in the box previously occupied by the infected monkeys. In this experiment the infection might have been carried by skin, urine, or ecto-parasites.

In the second experiment the healthy and the infected monkeys were placed in a small cage covered with coarse wire and divided into two compartments by netting with very large meshes; the netting was fastened to a wooden ledge so arranged that fluid could not pass from one cage to the other. The compartments were of such a shape that when the monkeys were sitting in the cage back to back the skins were in intimate contact, and the monkeys could not turn round. As an additional precaution the arms, legs, and buttocks were placed in mackintosh bags. Infection under these conditions might be carried by both skin and ecto-parasites.

In the third experiment a small mosquito-proof hut was divided into two compartments by fine wire netting fastened below to a board fixed to the terrace by cement. The conveyance of infection by urine, skin, and mosquitos was thus excluded, and only ecto-parasites, which would easily pass through the wire netting, could have operated in conveying the *Micrococcus melitensis* to the healthy animal.

The details of the experiments are as follows:—

Experiment I.—Monkey No. 91 and Monkey No. 95 were inoculated with the *Micrococcus melitensis*, subcutaneously, to act as infecting agents. Monkey No. 91 suffered from a long wave of fever, its temperature rose to 105° on May 29, and remained so with a few intermissions until June 19, when it slowly fell to normal. Its blood serum diluted 1/500 caused immediate agglutination of the *Micrococcus melitensis*. Monkey No. 95 had a wave of fever lasting from June 20 to June 27, and the blood serum diluted 1/100 reacted with the *Micrococcus melitensis*. The monkey died on July 21, and the specific microbe was recovered from the spleen, bile, mesenteric, femoral and axillary glands.

A wooden framework, covered with mosquito-proof netting, having been erected on the terrace of the Public Health Department, three boxes were placed inside it. On May 25 Monkey No. 92 and Monkey No. 91 were placed in contiguous boxes. The blood serum of No. 92 was examined, but no reaction was obtained.

June 13. Blood of Monkey No. 92 was examined, but no reaction was obtained.

June 14. Monkey No. 92 was found occupying the box of Monkey No. 91.

June 19. The blood of Monkey No. 92 was examined, but without any reaction.

June 24. The blood of Monkey No. 92 was again examined, with a similar result. Monkey No. 95 was put in a box, and the box of Monkey No. 92 was placed between those of Monkeys Nos. 91 and 95.

July 2, July 9, July 16, July 23, and August 9. The blood of Monkey No. 92 was examined, but no reaction appeared.

August 20. The blood serum of Monkey No. 92, diluted 1/10, was found to agglutinate the *Micrococcus melitensis* at once, the reaction being visible to the naked eye.

August 25. Two cubic centimetres of blood were removed from a saphenous vein and planted out in broth-tubes; after seven days' incubation at 37° C. no growth was obtained.

August 31. The blood serum, diluted 1/100, caused immediate clumping of the *Micrococcus melitensis*.

September 11. One cubic centimetre of blood was removed from a saphenous vein and planted out in broth-tubes; after seven days' incubation at 37° C. no growth was obtained.

September 13. The blood reaction was found, as recorded, on August 31.

October 4. The monkey was killed with chloroform. At the *post-mortem* examination the body appeared fairly nourished, and the spleen and glands were not enlarged. Cultures were made from the spleen, liver, kidneys, bile, heart's blood, mesenteric, femoral, and axillary glands. The *Micrococcus melitensis* was recovered from the glands, but the cultures made from the other organs appeared sterile.

Remarks.—The monkey had no rise of temperature during the experiment, and save for a slight loss of flesh appeared perfectly well. The boxes of the monkeys and the floor of the enclosure were cleansed as little as possible, so as to permit of the infection by urine as well as by the skin and by ecto-parasites. The presence of the *Micrococcus melitensis* in the glands showed that an infection had taken place, and that it was produced by the urine is proved by the results of Experiments II and III.

Experiment II.—A small narrow box covered at the sides with fine wire netting, and having a wooden bottom, was divided into two compartments, each just large enough to hold a monkey in the sitting position, by means of very coarse wire netting. A movable wire floor was sloped from the centre to the sides of each compartment, so that any fluid deposited on it would run off through the wire meshes into the space beneath. By this arrangement the possibility of urine passing from one cage to the other was completely obviated.

Monkey No. 91 was used as the infecting agent, and Monkey No. 88 as the contact.

Monkey No. 88 was kept under observation for 14 days, and its blood repeatedly examined before the experiment was commenced.

On June 8 the monkeys were placed in the cage back to back. The open wire netting of the partition permitted the backs to be in intimate contact, and was merely used to steady the monkeys and prevent them turning round. The arms and legs and buttocks of each monkey were placed in waterproof bags so as to prevent dried urine being conveyed by the. infected to the healthy monkey, should the former by any chance manage to turn round in the cage and pass its paws through the loose meshes of the partition. As soon as the monkeys were placed *in situ* the whole cage was covered with mosquito netting.

From June 8 to June 23 Monkey No. 91 and Monkey No. 88 were placed in contact daily for four hours. From June 24 to July 4 Monkey No. 95 was used as the infecting agent. The blood of Monkey No. 88 was examined on June 13, June 18, June 24, and July 2, but no signs of a reaction with *Micrococcus melitensis* were ever seen.

On July 5 Monkey No. 88 was seized with an acute attack of diarrhœa, and he died on July 12.

At the *post-mortem* examination all the organs appeared healthy. Cultures were made from the organs in the usual manner, but all proved sterile.

Remarks.—Infection by urine being excluded, this experiment seems to show that neither ecto-parasites nor intimate skin contact participate in the conveyance of infection from diseased to healthy monkeys.

Experiment III.—The object of this experiment was to ascertain whether ecto-parasites alone could convey infection from a diseased to a healthy monkey.

A small mosquito-proof hut, erected on the terrace of the Public Health Department, was divided into two compartments by strong wire netting, having a meshwork so fine that only small ecto-parasites such as fleas and bugs could pass through it. The wire netting was fastened below to a deal board a foot high and fixed by cement to the floor of the hut.

Monkeys Nos. 110, 92, and 101 were used as the infecting agents. Monkey No. 23, the healthy animal, was kept under observation for a fortnight before the experiment was commenced. Its blood was repeatedly tested, but no reaction with the *Micrococcus melitensis* was observed.

On September 5 Monkey No. 110, which had been injected subcutaneously with the *Micrococcus melitensis* specially for this experiment, was placed in one compartment of the hut, and Monkey No. 23 in the other, the chains of both animals being so arranged that when at full length they could not touch the wire partition. On September 10 Monkey No. 110 showed no sign of fever, and only a very feeble blood reaction. Monkey No. 92 was then placed in its compartment, to act as the infecting agent. On October 5 Monkey No. 92 was removed, and Monkey No. 101, then at the height of a wave of fever, was placed in the infected compartment. The blood of Monkey No. 23 was examined on September 14, 20, and 27, and on October 13 no signs of a reaction with *Micrococcus melitensis* could be detected.

The experiment was continued until November 12, Monkey No. 101 passing through a secondary wave of fever. The blood of Monkey No. 23 was repeatedly examined during November, but no signs of a reaction were observed. The monkey is still alive and well.

Remarks.—Ecto-parasites alone do not appear able to convey infection from a diseased to a healthy monkey.

As the experiments had failed to show that ecto-parasites and direct skin contact play any part in the infection of healthy monkeys living in intimate contact with diseased monkeys, and that the infection was probably caused by the absorption of urine containing the *Micrococcus melitensis*, it appeared desirable to ascertain by direct experiment whether a monkey could be infected by feeding with the urine excreted by Mediterranean Fever patients. Accordingly Monkey No. 119 was fed on urine added to dust and potato, etc.; the details of the experiment were as follows:—

Experiment IV.—Monkey No. 119 was kept under observation in a mosquito-proof chamber for several days before the experiment was commenced. On August 1 the blood was examined, but the serum gave no reaction. The monkey was then fed on fine sterilised dust moistened with urine from a case of Mediterranean Fever containing large numbers of the *Micrococcus melitensis*. The urine dust, thoroughly mixed with potato, was on this occasion readily eaten. On August 2, 3, and 4 the feeding was continued, but it was noticed that after the first feeding the monkey ate very little of the infected potato. On August 7, 8, and 9 attempts were made to get the monkey to drink the urine in its natural state, but with poor success. On August 10 a few cubic centimetres of urine were rubbed up with a considerable quantity of boiled potato, and, as the monkey ate the mixture readily, this method of feeding was continued daily until the 19th, after which date it was fed every other day until the 29th.

The blood was examined on August 11 and 12, but the serum gave no reaction. On August 28, however, slight clumping of the *Micrococcus melitensis* was caused by the serum, diluted 1/10. On August 30 the reaction was quite distinct, the serum being diluted 1/10. On September 5 the blood serum, diluted 1/100, caused instantaneous clumping of the *Micrococcus melitensis*. On September 15 the monkey was killed with chloroform.

At the *post-mortem* examination the spleen was found large, soft, and friable. The axillary, femoral, and mesenteric glands were also found enlarged.

Cultures were made from the spleen, liver, kidneys, bile, heart's blood, axillary, femoral, and mesenteric glands. The *Micrococcus melitensis* was recovered from the axillary, femoral, and mesenteric glands, the plates being crowded with colonies. It was also isolated from the spleen, but only a few colonies were found on the agar slopes. The remaining cultures proved sterile.

Remarks.—The monkey became infected about 28 days after the feeding was commenced. There was no rise of temperature during the experiment.

Summary.

1. So far as the experiments go it appears that infection cannot be conveyed from infected to healthy monkeys by skin contact alone, all other sources of infection being excluded.

2. That infection cannot be conveyed from infected to healthy monkeys by ecto-parasites alone.

3. That when healthy monkeys living in intimate contact with diseased monkeys, under mosquito-proof conditions, become infected, the infection is due to the absorption of the *Micrococcus melitensis* excreted in the urine of the diseased monkeys.

VI. GOATS AS A MEANS OF PROPAGATION OF MEDITERRANEAN FEVER.

By Major W. H. Horrocks, R.A.M.C., and Captain J. C. Kennedy, R.A.M.C.

(Received December 16, 1905.)

(Plate 1.)

In Part III of the Reports of the Commission a preliminary note was published on this subject, in which it was shown that goats in Malta suffer from Mediterranean Fever, and excrete the *Micrococcus melitensis* in their milk and urine. The further study of this subject may be divided into the following parts:—

I. Examination of goats living in pens (*a*) in the immediate neighbourhood of Valletta and Sliema, and (*b*) in the more remote parts of the Island.
II. Experiments made to determine the possibility of infecting animals by feeding them on milk-cultures and infected milk.
III. Experiments to determine the mode in which the goats themselves become infected.
IV. Experiments to determine whether it is possible to destroy the *Micrococcus melitensis* by Pasteurisation of the infected milk.

I. Examination of Goats Living in Pens (*a*) in the Immediate Neighbourhood of Valletta and Sliema, and (*b*) in the More Remote Parts of the Island.

(*a*) *Examination of Goats Supplying Milk to Forrest Hospital.*

This herd consisted of 15 goats, and five reacted to the *Micrococcus melitensis*. The serum of Goat No. 37 reacted in a dilution of 1/60, but the sera of Goats Nos. 38, 39, 43, and 48 only reacted in a dilution of 1/20.

Goat No. 37.—This goat was in good health, and its udders were full of milk. On July 4, 5, and 6 the plates made with the deposit from 2 c.c. of the milk were found densely crowded with small colonies of the *Micrococcus melitensis*. The milk was again examined on August 12, September 6, and October 8, and on each of these occasions the plates were found densely crowded with colonies of the microbe. The physical characters of the milk appeared perfectly normal at each examination.

Goat No. 38.—The milk from this goat was centrifugalised, and the deposit plated on July 4, 5, 6, 7, 8, 10, 14, 17, 18, 25, August 19, September 6, and October 8. The *Micrococcus melitensis* was never recovered.

Goat No. 48.—The milk from this goat was examined on the same dates as No. 38. The *Micrococcus melitensis* was not isolated.

Goat No. 43.—The milk from this goat was also examined on the same dates as No. 38. The *Micrococcus melitensis* was not recovered.

Remarks.—The examination of Goat No. 37 shows that the *Micrococcus melitensis* may be excreted steadily in milk for three months without any change occurring in its physical characters. It was thought that Goats Nos. 38, 43, and 48 might be in an earlier stage of the disease than No. 37, and that if they were kept under observation the *Micrococcus melitensis* might eventually appear in the milk. Though the goats were kept under examination for three months, the specific *Micrococcus melitensis* was never recovered from the milk.

Examination of a Small Herd Supplying Milk to Valletta Hospital.

This herd consisted of 13 goats, and four reacted to the *Micrococcus melitensis.*

Goat No. 30.—The serum of this goat reacted only in a dilution of 1/20. The microbe was recovered from the milk from July 1 to July 6, but after this it disappeared.

Goats Nos. 27 *and* 32.—The milk from these goats was examined during June, July, August, and September, but no signs of the *Micrococcus melitensis* were detected. The serum of Goat No. 27 reacted in a dilution of 1/100, and that of No. 32 in a dilution of 1/60.

Remarks.—The *Micrococcus melitensis* was not isolated from the milk of the two goats which judged by the serum reaction would have been considered the most severely infected. In the case of Goat No. 30 the excretion of the parasite continued only for one week, though the secretion of the milk was maintained in good quantity and quality for three months.

Examination of a Small Herd Supplying Milk to Valletta.

This herd consisted of 25 goats, and 17 showed a blood reaction.

Goat No. 50.—Plates made from the milk of this animal were found densely crowded with colonies of the *Micrococcus melitensis.*

Goat No. 52.—During the first week of July the milk of this goat was found to be markedly infected, but examinations made in August, September, and October failed to show any signs of the *Micrococcus melitensis*, though the quantity and quality of the milk continued good.

Goat No. 68.—The milk of this goat contained a comparatively small quantity of the *Micrococcus melitensis*, only 100 colonies being found in the plates made with the deposit from 1 c.c.

Remarks.—The severity of the infection of these goats, judged by the serum reaction, should have been the same, and as the animals were in full milk, the excretion of the microbe might have been expected to occur to the same extent in all the animals. Such was not the case, and judged by the excretion in the milk it appeared that Goat No. 68 was only infected to a small extent.

Examination of a Small Herd Supplying Milk to Sliema.

Two goats were bought from this herd and placed in the Lazaretto.

Goat No. 15.—The milk of this animal contained large quantities of the *Micrococcus melitensis* during the first week of July, but examinations made in August, September, and October failed to demonstrate the presence of the specific *Micrococcus melitensis.* The quantity and quality of the milk, however, continued good.

Goat No. 16.—The milk of this goat was examined during July, August, September, and October, but no signs of *Micrococcus melitensis* were detected. The blood serum, diluted 1/60, caused immediate agglutination of the microbe when the animal was bought in July, and examinations made at later dates showed that the blood reaction was unchanged.

Remarks.—It appears from the results obtained in the case of Goat No. 16 that an animal may have a marked blood reaction lasting for four months, and yet never excrete the *Micrococcus melitensis* in its milk.

Examination of Goats at Hamrun.

These goats supply a large portion of the milk consumed in Valletta.

The following herds were examined:—

Herd No. 1.—This consisted of 46 goats, and 26 reacted to the *Micrococcus melitensis, i.e.*, 6 in a dilution of 1/100, 4 in a dilution of 1/60, 2 in a dilution of 1/40, 9 in a dilution of 1/20, and 5 in a dilution of 1/10. Only one of these goats showed an excretion of *Micrococcus melitensis* in the milk, and the blood serum reacted in a dilution of 1/100.

Herd No. 2.—There were 30 goats in this herd; the *Micrococcus melitensis* was only found in the milk of one goat. The blood could not be examined, as the owner of the goats refused to allow a specimen to be taken.

Herd No. 3.—There were 26 goats in this herd. The *Micrococcus melitensis* was not isolated from the milk of any of them.

Herd No. 4.—There were 45 goats in this herd. All proved to be quite healthy. No signs of the *Micrococcus melitensis* could be discovered in the milk.

Herd No. 5.—This herd consisted of 32 goats. The milk from five of them was found to contain the *Micrococcus melitensis* in large quantity.

Remarks.—Only 3·3 per cent. of the goats examined contained the *Micrococcus melitensis* in the milk.

Examination of Goats at Pieta.

These goats supplied milk to Valletta; there were 32 animals in the herd and 24 reacted to the *Micrococcus melitensis*, *i.e.*, 13 in a dilution of 1/100, 1 in a dilution of 1/60, 2 in a dilution of 1/40, 4 in a dilution of 1/20 and 4 in a dilution of 1/10. The large number of goats with a high serum reaction was remarkable. Only six goats were found excreting the *Micrococcus melitensis* in the milk, and the sera of all of these reacted in a dilution of 1/100.

Remarks.—About 18·7 per cent. of the goats in this herd were found excreting the *Micrococcus melitensis* in the milk.

Examination of Goats at Paolo.

These goats supplied milk to Paolo and parts of Cospicua and Senglea. There were 24 goats in the herd, and 17 reacted to the *Micrococcus melitensis*. Only three goats were found excreting the microbe in the milk; the blood of two of the goats reacted in a dilution of 1/100 and the third in a dilution of 1/60. Three goats having a blood reaction of 1/100 showed no signs of the microbe in the milk.

Remarks.—About 12·5 per cent. of the goats in this herd were found excreting the *Micrococcus melitensis* in the milk, though judged by the blood reaction some 70 per cent. were infected.

Examination of Goats at Attard.

There were 19 goats in this herd which supplied milk to Attard. None of the goats reacted to the *Micrococcus melitensis*, and the milk of all of them was quite free from infection.

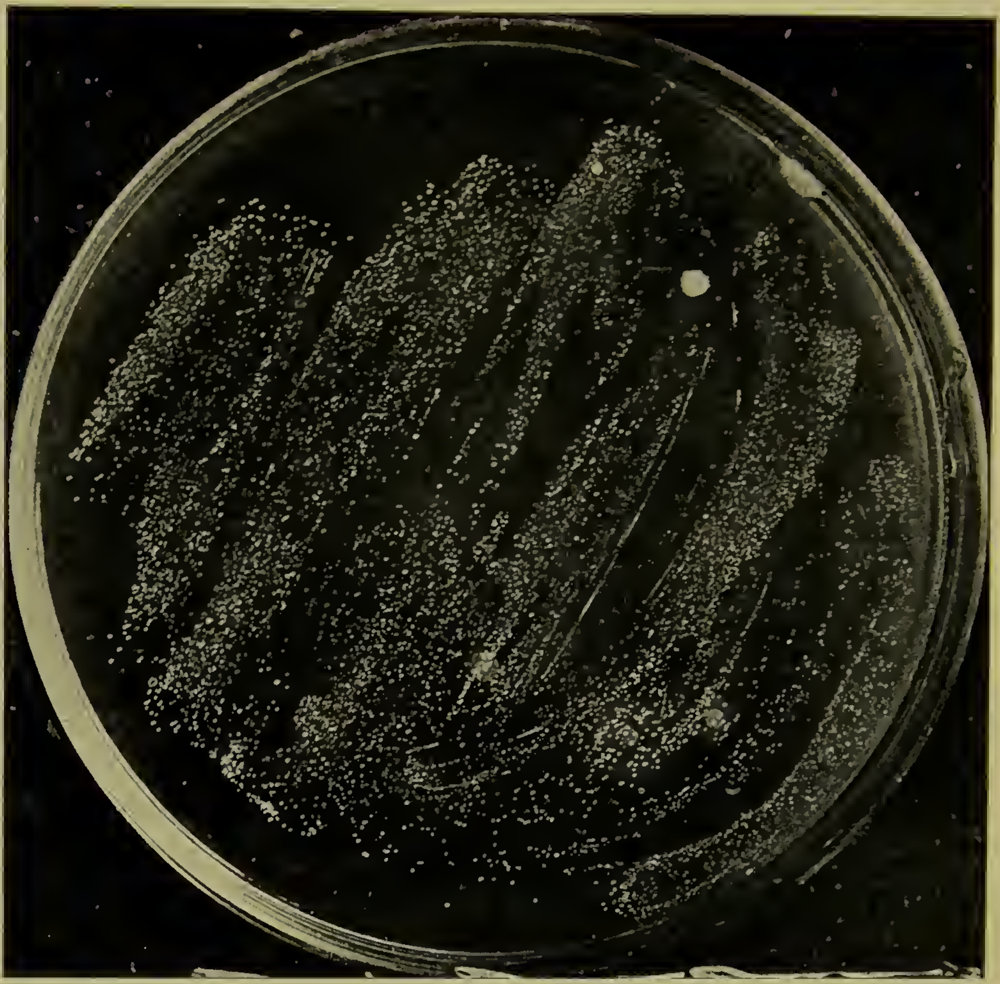
Examination of Goats at Citta Vecchia.

These goats supplied the Military Hospital; there were 15 animals in the herd, and 11 were found to react with the *Micrococcus melitensis*. The milk of five goats was found to contain the specific *Micrococcus melitensis*, and of these the blood sera of three reacted in a dilution of 1/100, the serum of the fourth in a dilution of 1/60, and the serum of the fifth in a dilution of 1/40.

Remarks.—About 33 per cent. of the goats supplying the Military Hospital were found excreting the *Micrococcus melitensis* in the milk.

Examination of Goats at Zeitung.

These goats supplied the three cities. There were 93 animals in three herds. The milk of only one goat was found to contain the *Micrococcus melitensis*.



Milk from a goat in a herd at Zabbar. 10 c.c. centrifugalised and three drops of the deposit spread on a glucose nutrose-litmus-agar plate. Incubated 4 days at 37° C.

From photo. by Staff-Sergeant Rossiter, R.A.M.C.

Examination of Goats at Zabbar. (Plate 1.)

Four herds were examined. There were 44 goats in the first herd, and the *Micrococcus melitensis* was found in the milk of four of them. In the second herd, containing 28 goats, no signs of the microbe could be found in the milk of any of the animals. In the third herd there were 41 goats; the *Micrococcus melitensis* was found in the milk of only one animal. In the fourth herd, consisting of 19 goats, the milk of one was found to contain the *Micrococcus melitensis.*

Remarks.—About 4·5 per cent. of the goats were found excreting the *Micrococcus melitensis* in the milk.

Examination of Selected Goats at Balzan.

The goats were first subjected to the milk test, and 21 of them showed a tendency to agglutinate the *Micrococcus melitensis.* The milk from these animals was carefully "plated," but the microbe was only recovered from the milk of six of them.

Remarks.—About 29 per cent. of the goats selected by the milk agglutination test were found excreting the *Micrococcus melitensis* in the milk.

Examination of Selected Goats at Casal Lia.

These goats were also subjected to the milk test, and 13 appeared to be infected. The *Micrococcus melitensis*, however, was only found in the milk of four of them.

Remarks.—About 30 per cent. of the selected goats were found excreting the *Micrococcus melitensis* in the milk. The percentage was practically the same as that obtained in the case of the goats selected at Balzan.

Examination of Selected Goats at Zabbar.

Five appeared to be infected, judged by the milk test, and the *Micrococcus melitensis* was found in the milk of two of them.

Remarks.—About 40 per cent. of the selected goats appeared to contain the *Micrococcus melitensis* in the milk, but the figures are too small to be of any practical value.

Examination of Goats at Melleha.

There were 91 goats in the herds, and 16 showed a reaction with the *Micrococcus melitensis*; the specific microbe was not found in the milk of any of them.

Examination of Goats at the Lunatic Asylum.

There were 31 goats in this herd, which was kept in the Asylum grounds. The goats were not allowed to graze in the public streets. A careful examination of the milk, by means of the agglutination test, was made, but no reaction was obtained. Ten cubic centimetres of milk from each animal was then centrifugalised and the deposit "plated;" no signs of the *Micrococcus melitensis* were observed in any of the plates.

The following table gives the degree of reaction obtained in each of the infected goats, worked out to a dilution of 1/100.

Each goat is designated by a number, which is placed in the column corresponding to the highest dilution in which its blood reacted:—

	Dilutions.						
	1/10.	1/20.	1/40.	1/60.	1/80.	1/100.	Total.
Herd I	2 80	74 78	1 75			83	7
" II						5	1
" III							0
" IV		22 30		32		27	4
" V		38 39 43 48		37			5
" VI	51 59 62 63 65 73	54 66 67 70		64		50 52 55 60 68 71	17
" VII	97 109 117 120 123	88 93 96 106 110 112 113 125 128	85 90	103 111 119 126		99 102 105 121 122 129	26
" VIII	137 140 144 148	134 135 141 149	131 157	147		132 133 136 138 145 151 153 154 155 156 152 160 161	24

	Dilutions.						
	1/10.	1/20.	1/40.	1/60.	1/80.	1/100.	Total.
Herd IX	167 169 185 200 208 215 232 234 242 247	166 174 202 231	163	191			22
,, X	253 255						2
,, XI	281	283	268 273 277 282	261 266 271 274 279	278	260 263 264 270 280	17
,, XII	288 294					302	3
,, XIII	307 316	313 318	311	310	326	309 314 315 321	11
,, XIV	3	7 8 9				1	5
Total number of goats	35	35	12	15	2	39	138

Blood Examination of Goats from various parts of Malta.

Herds and number of goats.	Address.	Supply milk to	Total number tested.	Number which gave a definite blood reaction.	Percentage of reactions.
I Nos. 1 to 4 and 74 to 83	Casal Tarshiel, near Casal Paolo	Cottonera Hospital, Zabbar Gate, and near-lying part of town	14	7	50·0
II Nos. 5 to 17	Zabbar …………	„ „	13	1	7·69
III Nos. 18 to 20	Hamrum ………	Valletta …………	3	0	0·0
IV Nos. 21 to 33	Casal Curmi ……	Valletta Hospital and town	13	4	30·6
V Nos. 34 to 48	St. George's Bay	Forrest Hospital.	15	5	33·3
VI Nos. 49 to 73	St. John's Ditch	Valletta …………	25	17	68·0
VII Nos. 84 to 129	Hamrun ………	„ …………	46	26	56·5
VIII Nos. 130 to 161	Pieta ……………	„ …………	32	24	75·0
IX Nos. 162 to 252	Melleiha village	Melleiha Camp, Ghain Tuffeiha, Melleiha village, and 1 mile radius	91	16	17·6
X Nos. 253 to 259	Birchircara ……	Birchircara village	7	2	28·5
XI Nos. 260 to 283	Paolo ……………	Paola and near-lying parts of Cospicua and Senglea	24	17	70·8
XII Nos. 284 to 306	Ghashak…………	Cospicua, Senglea, and Cottonera	23	3	13·0
XIII Nos. 307 to 330	Citta Vecchia …	Hospital…………	15	11	73·3
XIV Private herd Nos. 1 to 10	Sliema ….. …..	A few private houses, Sliema	10	5	50·0

Total number of goats examined …………… 331
Number which gave a reaction ……………… 138
Percentage of goats found infected = 41·69

Examination of Goats' Milk for Agglutinative Reaction to Micrococcus melitensis (*Zammit's Test*).

Two methods were tried:—

1. Sedimentation in Tubes.—The milk was diluted with four times the amount of emulsion of *Micrococcus melitensis* and left standing for 12 hours in sedimentation tubes. This method was found to be unreliable, as the sediment often consisted of fat and *débris*, and always required to be submitted to microscopic examination.

2. Agglutination under the Microscope.—Equal parts of milk and emulsion were placed on a slide and allowed to stand for 12 hours in a moist chamber. At the end of this time the fatty part of the milk had collected in the centre and the surface of the drop, leaving the edges and the bottom clear. The clear part was then examined under 1/6 inch lens for clumping of *Micrococcus melitensis.* It should be noted that the milk was prevented from turning sour by adding one drop of 40 per cent. of formalin to 10 c.c. of milk.

The second method was found much the more certain, and, after a trial of 57 samples of milk examined in both ways, was adopted in preference to the first. Samples of the milk of 57 goats whose blood had been tested were examined in both these ways. The examination of the blood showed a positive agglutinative reaction to *Micrococcus melitensis* in 41. The milk gave a positive reaction—(1) by sedimentation in 17, (2) by microscope in 27.

In all, the reaction of 115 samples of milk was examined, and a positive reaction was obtained in 47. All these samples were more or less selected, and cannot be taken as a fair average; of these, 86 were examined for serum reaction, with the following result:—

Blood positive, milk positive ……	42	= 48·8 per cent.
Blood positive, milk negative ……	16	= 18·6 ,,
Blood negative, milk negative……	28	
	86	

∴ Milk gave a reaction in only 72·4 per cent. of those giving a serum reaction.

The numbers of the 16 goats (blood positive and milk negative) mentioned above are as follows:—

No. of goat.	Reaction of blood in dilutions.	Whether *Micrococcus melitensis* was found in milk?
43	1/10	No.
48	1/20	,,
112	1/20	,,
119	1/40	,,
140	1/10	,,
163	1/40	,,
174	1/10	,,
215	1/10	,,
232	1/10	,,
281	1/10	,,
282	1/40	,,
288	1/10	Not examined.
302	1/100	—
313	1/10	No.
316	1/10	,,
318	1/20	,,

Remarks on the goats whose blood was examined for reaction to Malta Fever.

It was expected that those goats whose blood reacted would have some symptoms of illness, but this was not apparent except in a few instances. A few goats were noticed to have an unusual degree of lassitude and to be off food. In the later stages of the infection, when the milk was beginning to dry up, a short, hacking cough was noticed, and the goats appeared to steadily lose flesh, the coat also became thin. The quantity and quality of the milk seemed in most cases to be unaffected, indeed it was remarked how often the best milkers in the herd were picked out as a result of the blood examination.

The following goats reacted in a dilution of 1/100, and their daily milk production was as follows:—

No. of goat.	Quantity of milk in pints.
132	3
133	3
136	5
138	2
151	6
153	2
154	6
156	4
159	2
160	2½

A good average milk production is from four to five pints a day, so it appears that when the blood reaction is very marked there may be a diminution in the quantity, though the physical characters and chemical composition of the milk remain unchanged.

Pregnancy goes on uninterruptedly in infected goats; a miscarriage was reported only in one instance.

The Relation of the Blood and Milk Agglutination to the Infection of the Milk.

As a rule, if the blood agglutination was over 40 dilutions, the milk reaction was present in 85 per cent.

If the blood agglutination reached only 20 dilutions, the milk reaction was present in 60 per cent., and in 10 dilutions only 30 per cent.

The following are the numbers of some goats where the reaction in the blood did not go beyond a dilution of 1/10, yet the milk reaction was present:—

307, 148, 137, 39, 38, 185.

It is thrown out as a suggestion that the presence of the reaction in the milk may be a better guide to the presence of *Micrococcus melitensis* in the milk than the examination of the blood, especially when a good case can be brought forward, such as Goat No. 4 (Lazaretto).

In this case the milk reaction was present, though the blood reaction was only 1/10, and at the same time *Micrococcus melitensis* was being excreted in the milk in very considerable quantities. However, as the excretion of *Micrococcus melitensis* continued in the milk, the blood agglutination crept up until it reached 1/40.

II. TO TEST THE VIRULENCE OF THE *Micrococcus melitensis* EXCRETED IN GOATS' MILK, AND THE POSSIBILITY OF INFECTING ANIMALS BY FEEDING WITH MILK CULTURES AND INFECTED MILK.

(A) *To Test the Virulence of* Micrococcus melitensis *Isolated from Goats' Milk.*

Monkey No. 107 was brought from Calcutta and placed on the terrace of the Public Health Department:—

1905—

July 18. Examined blood; no reaction obtained.

„ 19. Injected subcutaneously, growth on an agar slope, isolated from the milk of infected goat No. 5.

„ 25. Examined blood; dilution 1/10 reacted at once, visible to naked eye.

„ 30. Examined blood; dilution 1/10 reacted at once, dilution 1/20 reaction not complete.

1905—
July 31. Drew off 2 c.c. of blood from saphenous vein and planted out in broth.
Aug. 7. Planted out growth in broth on an agar slope, typical growth of *Micrococcus melitensis* resulted.
„ 20. Examined blood; dilution 1/50 reacted, but clumping not quite complete.
Sept. 2. Removed 1·5 c.c. of blood from saphenous vein; after seven days' incubation at 30° C. no growth resulted.
„ 3. Examined blood; dilution 1/100 reacted at once.
„ 13. Examined blood; reaction as on the 3rd.
„ 20. Monkey ill and steadily losing flesh.
„ 26. Monkey dying. Killed with chloroform.

Post-mortem Examination.—Body much emaciated; lymphatic glands not appreciably enlarged; spleen very small; liver mottled.

Cultures were made from spleen, liver, kidneys, heart's blood, bile, mesenteric, femoral, and axillary glands.

The *Micrococcus melitensis* was recovered from the mesenteric glands, all the other organs remained sterile.

(B) *To Determine the Possibility of Infecting Monkeys and Goats by Feeding with Cultures of* Micrococcus melitensis *Isolated from Milk.*

Experiment I.—Monkey No. 6 was brought from Calcutta and placed in a mosquito-proof chamber in the Lazaretto:—

1905—
July 30. Examined blood; no reaction obtained.
Aug. 1. Fed on *Micrococcus melitensis* isolated from milk of Goat No. 99, growth on an agar slope being made into a paste with potato.
„ 5. Fed as on the 1st, culture of *Micrococcus melitensis* isolated from milk of Goat No. 17 being used.
„ 8. Fed as on the 5th.
„ 9. Fed as on the 5th; culture isolated from milk of Goat No. 15 used.
„ 10. Examined blood; no reaction obtained.
„ 12. Fed as on the 9th.
„ 17. Fed as before; culture isolated from milk of Goat No. 5 used.
„ 21. Examined blood; no reaction obtained.
„ 22. Fed as on the 17th.
„ 24. Fed as on the 5th.
„ 25. Examined blood; no reaction obtained.
Sept. 1. Examined blood; serum, diluted 1/10, reacted at once, clumps visible with naked eye.

1905—

Sept. 4. Removed 2 c.c. of blood from saphenous vein and planted out in broth tubes. After seven days' incubation at 37° C., no growth obtained.

„ 5. Examined blood; serum, diluted 1/100, reacted at once.

„ 6. Killed the monkey with chloroform.

Post-mortem Examination.—Body well nourished; spleen slightly enlarged; liver congested; femoral and axillary glands markedly enlarged; mesenteric glands slightly enlarged.

Cultures were made from the spleen, liver, kidneys, bile, heart's blood, mesenteric, femoral, and axillary glands.

The *Micrococcus melitensis* was recovered from all the cultures except those made with the bile.

The agar slopes inoculated with the spleen, and the plates, over which sections of the glands had been rubbed, were densely crowded with colonies.

Remarks.—The monkey never suffered from fever, and gained in weight during the experiment. The animal was killed five days after the blood reacted, in the hope of ascertaining whether the mesenteric glands were infected earlier and to a greater extent than the axillary and femoral glands. No difference, however, could be ascertained between the glands; all the organs appeared to be teeming with the *Micrococcus melitensis.* The intestines were carefully examined, and no signs of any abrasion or inflammation in the mucous membrane could be detected. This experiment proves that the *Micrococcus melitensis* can be absorbed through a healthy mucous membrane, and shows that the organs may be extensively infiltrated with the *Micrococcus melitensis* without apparently producing any prejudicial effect on the health of the animal during the first week after absorption.

Experiment II.—Monkey No. 7 was brought from Calcutta and placed in a mosquito-proof chamber in the Lazaretto.

1905—

July 30. Examined blood; no reaction obtained.

Aug. 1. Fed on potato mixed with an agar culture of *Micrococcus melitensis* isolated from infected Goat No. 154.

„ 5. Fed on potato mixed with an agar culture of *Micrococcus melitensis* isolated from infected Goat No. 30.

„ 8. Fed as on the 5th.

„ 9. Fed as on the 5th.

„ 10. Fed as on the 5th. Examined blood; no reaction obtained.

„ 12. Fed as on the 5th, but culture isolated from Goat No. 17 used.

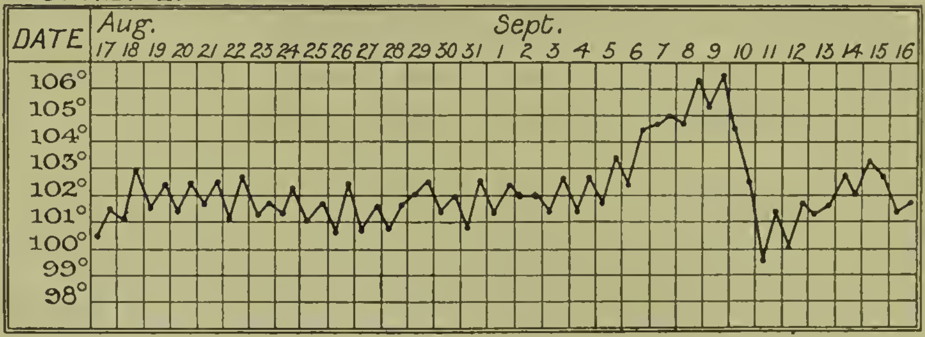
„ 17. Fed as before, agar culture isolated from Goat No. 5 used.

1905—
Aug. 22. Fed as on the 17th.
,, 24. Fed as on the 17th, agar culture isolated from Goat No. 60 used.
,, 25. Examined blood; no reaction obtained.
Sept. 1. Examined blood; no reaction obtained.
,, 5. Examined blood; serum, diluted 1/50, reacted at once.
,, 10. Removed 1 c.c. of blood from saphenous vein and planted in broth-tubes; after seven days' incubation at 37° C. no growth obtained.
,, 11. Examined blood; serum, diluted 1/100, reacted at once.
,, 15. Removed 2 c.c. of blood from saphenous vein and planted out in broth-tubes; after seven days' incubation at 37° C. no growth obtained.
,, 20. Examined blood; serum, diluted 1/1000, reacted at once.
,, 24. Killed monkey with chloroform.

Post-mortem Examination.—Body well nourished; femoral and axillary glands enlarged, mesenteric glands not enlarged; spleen enlarged, soft and friable; liver very congested. Cultures were made from the spleen, liver, kidneys, heart's blood, bile, mesenteric, axillary, and femoral glands. The *Micrococcus melitensis* was recovered from the mesenteric, femoral, and axillary glands, the heart's blood, and spleen. The plates inoculated with sections of the glands were densely crowded with colonies, but though 12 agar slopes were inoculated with sections of the spleen, only a few colonies were found on four of them.

The following chart shows the temperature of the monkey during the experiment.

MONKEY 7.



Remarks.—This monkey suffered from a typical wave of fever like Monkey No. 5, fed on infected goat's milk. The distribution of the *Micrococcus melitensis* was very similar in the two monkeys. The interval between the commencement of feeding and the first sign of infection was longer in Monkey No. 7, though it received very much larger doses of the *Micrococcus melitensis.*

Experiment III.—Monkey No. 8 was brought from Calcutta and placed in a mosquito-proof chamber in the Lazaretto.

1905—
July 30. Examined blood; no reaction obtained.
Aug. 1. Fed on potato mixed with an agar culture of *Micrococcus melitensis*, isolated from Goat No. 50.
,, 8, 10, 12 and 18. Fed as on the 1st.
,, 22. Fed on agar culture, isolated from Goat No. 261.
,, 24. Fed on agar culture, isolated from Goat No. 138.
,, 10. Examined blood; no reaction obtained.
,, 17. Examined blood; no reaction obtained.
,, 25. Examined blood; slight tendency to a reaction observed.
Sept. 1. Examined blood; serum, diluted 1/10, reacted at once.
,, 7. Examined blood; serum, diluted 1/500, gave an immediate reaction.
,, 8. Removed 2 c.c. of blood from saphenous vein and planted out in broth-tubes; after seven days' incubation at 37° C., no growth obtained.
,, 14. Removed 2 c.c. of blood and treated as on the 8th, no growth of *Micrococcus melitensis* observed.
,, 29. Killed the monkey with chloroform.

Post-mortem Examination.—Body well nourished; spleen large and soft; liver and kidneys congested; mesenteric, axillary and femoral glands enlarged.

Cultures were made from the spleen, liver, kidneys, bile, heart's blood, mesenteric, axillary, and femoral glands. A few colonies of the *Micrococcus melitensis* were found in the plates made from the mesenteric, axillary, and femoral glands. All the other cultures proved to be sterile.

Remarks.—This monkey never suffered from fever and put on weight during the experiment.

Experiment IV.—Monkey No. 9, brought from Calcutta and placed in a mosquito-proof chamber in the Lazaretto.

1905—
July 30. Examined blood; no reaction obtained.
Aug. 1. Fed on potato mixed with an agar culture of *Micrococcus melitensis* isolated from Goat No. 105.
,, 5, 8, 9, and 10. Fed as on the 1st.
,, 12. Fed on agar culture isolated from Goat No. 7.
,, 17. Fed on agar culture isolated from Goat No. 15.
,, 22. Fed on agar culture isolated from Goat No. 309.
,, 24. Fed on agar culture isolated from Goat No. 261.
,, 10 and 17. Blood examined; no reaction obtained.
,, 25. Examined blood; distinct reaction after standing for 24 hours.
Sept. 1. Examined blood; serum diluted 1/10; reacted at once.

1905—
Sept. 7. Removed 2 c.c. of blood from saphenous vein, and planted out in broth-tubes; after seven days' incubation at 37° C. a growth of *Micrococcus melitensis* appeared, which gave all the characteristic tests. Examined blood; serum, diluted 1/1000, gave an immediate reaction.
„ 29. Suffering from fever and losing flesh.
Oct. 2. Very ill, fever still present.
„ 5. Monkey died this morning.

Post-mortem Examination.—Fairly nourished; spleen enlarged; liver congested; mesenteric glands not much enlarged, but congested. A little peritonitis present around the colon.

Cultures were made from the spleen, liver, kidneys, heart's blood, bile, mesenteric, femoral, and axillary glands.

The *Micrococcus melitensis* was recovered from the femoral and axillary glands.

Remarks.—The rise of temperature and subsequent death of this monkey were caused by the peritonitis around the colon. There were no signs of erosion or perforation of the intestine. The peritonitis was probably due to an external injury caused by an iron bracket placed in the wall for the monkey to sit upon.

To Determine the Period of Incubation.

Experiment V.—Monkey No. 19A was placed in a mosquito-proof chamber in the Lazaretto, and kept under observation for a month before the feeding was commenced. Its blood was repeatedly tested, but no reaction was ever obtained. On September 4 it was fed with the growth of an agar slope of *Micrococcus melitensis* isolated from the milk of Goat No. 15. On September 5 the feeding was repeated, but after this date no more culture was given. The blood was examined on September 10, 19, and 23, and on October 5, but no reaction was obtained. On October 7, however, the blood serum, diluted 1/10, caused immediate agglutination of the *Micrococcus melitensis*, the reaction being visible with the naked eye. On October 15 the blood reaction was noticed to be diminishing, as the serum, diluted 1/10, only gave an incomplete reaction with the *Micrococcus melitensis.* On October 16 the monkey was killed with chloroform. At the *post-mortem* examination all the organs appeared healthy. Cultures were made from the spleen, kidneys, liver, bile, heart's blood, and glands. A profuse growth of the *Micrococcus melitensis* was obtained from the spleen and from the femoral and axillary glands. The *Micrococcus melitensis* was also recovered from the heart's blood. The other cultures proved to be sterile.

Remarks.—The monkey never suffered from fever during life, and did not show any signs of ill-health. Although the blood serum had a very feeble agglutinating reaction, the spleen and glands were extensively infiltrated with the *Micrococcus melitensis.*

The period of incubation appeared to be about 32 days.

Feeding Experiment with Milk Cultures.

Goat No. 12 was placed in the Lazaretto and kept under observation for one month before the experiment was commenced.

1905—
June 26. Examined blood; no reaction obtained.
July 30. Examined blood; no reaction obtained.
,, 31. The growth on one agar slope of *Micrococcus melitensis*, isolated from milk of Goat No. 160, emulsified in water and poured down the throat, no gag being used.
Aug. 5. Fed again as on the 31st.
,, 8. Milk withdrawn from udder, 10 c.c. centrifugalised, and deposit plated on surface of glucose-nutrose-agar plates. No signs of *Micrococcus melitensis* detected.
,, 12. Examined blood; no reaction obtained.
,, 25. Fed on one agar slope of *Micrococcus melitensis*, isolated from milk of Goat No. 5.
,, 29. Fed as on the 25th.
,, 30. Examined blood; no reaction obtained.
Sept. 3. Fed as on the 25th.
,, 5. Fed as on the 25th.
,, 6. Examined blood; no reaction obtained.
,, 9. Fed as on the 25th.
,, 11. Examined blood; no reaction obtained.
,, 13. Fed as on the 25th.
,, 20. Examined blood; no reaction obtained.
,, 26. Examined blood; dilution 1/10, reaction at once.
Oct. 1. Drew off milk, centrifugalised 10 c.c. and plated deposit; no signs of *Micrococcus melitensis* detected.
,, 2. Examined blood; dilutions 1/10, 1/20, and 1/50 gave a complete reaction at once.
,, 6. Removed 5 c.c. of blood from jugular vein and planted in broth-tubes. After seven days' incubation at 37° C. no growth was obtained.
,, 9. Drew off milk, centrifugalised 10 c.c. and plated deposit; no signs of *Micrococcus melitensis* detected.
,, 16, 23, and 30. Milk examined as on the 9th; *Micrococcus melitensis* not recovered.

The examination of the milk and blood was continued once a week until November 30. The blood still reacted in a dilution of 1/40, but no signs of the excretion of the *Micrococcus melitensis* in the milk appeared. The goat is still under observation.

Remarks.—This experiment shows either that the *Micrococcus melitensis* is not always excreted in the milk of goats having a marked blood reaction, or that the excretion is a very late phenomenon.

Experiments to Determine the Possibility of Infecting Monkeys by Feeding them with Goat's Milk Containing the Micrococcus melitensis.

Experiment I.—Monkey No. 5 was brought from Calcutta and placed in a mosquito-proof chamber in the Lazaretto, Malta.

1905—

July 26. Examined blood; serum gave no reaction with the *Micrococcus melitensis.*

„ 27. Fed once a day on milk derived from a small herd of infected goats. There were 11 goats in the herd and the serum from all of them gave a reaction with the *Micrococcus melitensis.* The *Micrococcus melitensis*, however, was only present in the milk of nine of them. A gag was not used; at first the mouth was opened slightly by pressing externally with the thumb and first finger opposite the last molar teeth, but after a few days the monkey learned to lap up milk like a cat.

July 28 to Aug. 6. Feeding continued once a day.

Aug. 4. Feeding continued. Blood examined, serum gave no reaction with the *Micrococcus melitensis.*

„ 5. Feeding continued once a day.

„ 6. Milk given three times a day.

„ 7. Milk given three times a day. Blood examined and no reaction obtained.

„ 8. Milk given three times a day. Blood examined and no reaction obtained.

„ 9. Milk given three times a day. Blood examined and no reaction obtained.

„ 10 to 14. Feeding continued three times a day.

„ 15. Feeding continued. Blood examined; serum showed a slight tendency to react with the *Micrococcus melitensis.*

„ 16. Feeding continued. Blood examined: no distinct reaction obtained.

„ 17 to 25. Feeding continued. The blood was examined on the 21st and 23rd, but no reaction was obtained.

„ 25. Blood examined; complete reaction obtained, serum diluted 1/10. Dilution 1/30 gave no reaction.

1905—

Aug. 27. One cubic centimetre of blood removed from a saphenous vein planted out in broth and incubated at 37° C. Incubation continued for seven days and the broth then planted out on agar slopes. No growth resulted.

Examined blood. Reaction at once, visible to naked eye, serum diluted 1/10. Dilution 1/30 gave a complete reaction after half-an-hour.

" 28. Removed 1 c.c. of blood from a saphenous vein and treated as on the 27th; no growth resulted.

" 31. Examined blood; serum diluted 1/100 gave a reaction at once. Dilution 1/200 gave an incomplete reaction after one hour.

Sept. 5. One cubic centimetre of blood removed from a saphenous vein and planted out in broth. After incubation at 37° C. for seven days no growth resulted.

" 6. Two cubic centimetres of blood removed from a saphenous vein and planted out in broth. After incubation at 37° C. for seven days no growth resulted.

" 7. Examined blood; serum, diluted 1/100, reacted at once.

" 11. Examined blood; serum, diluted 1/1000, reacted at once. Killed the monkey with chloroform.

Post-mortem Examination.—Body well nourished; axillary, femoral, and mesenteric glands enlarged; spleen very large and soft and friable in consistence; liver enlarged and congested; kidneys congested; intestines congested in patches. Cultures were made as follows:—

Spleen.—Planted out on agar slopes (12) and in broth tubes.

Liver.—Planted out on agar slopes (12) and in broth tubes.

Kidney.—Planted out on agar slopes (12) and in broth tubes.

Heart's Blood.—Planted out in broth tubes.

Bile.—Planted out on the surface of glucose-nutrose-agar plates.

Urine.—Planted out on the surface of glucose-nutrose-agar plates.

Axillary Glands.—Sections made and the surfaces rubbed over glucose-nutrose-agar plates.

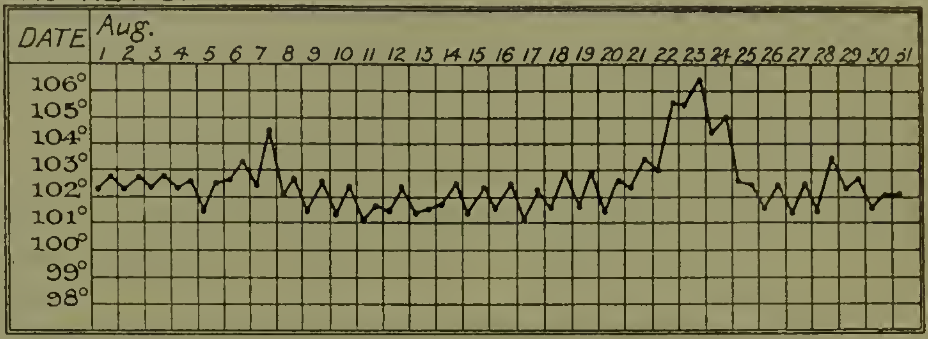
Femoral Glands.—Sections made and the surfaces rubbed over glucose-nutrose-agar plates.

Mesenteric Glands.—Sections made and the surfaces rubbed over glucose-nutrose-agar plates.

After four days' incubation at 37° C., all the plates made from the glands were found densely crowded with colonies of the *Micrococcus melitensis.* Out of the 12 agar slopes inoculated with the spleen only one showed the microbe, and on this slope only four colonies were counted. The cultures made from the liver, kidney and heart's blood remained sterile. No sign of the *Micrococcus melitensis* could be detected in the plates made from the bile and urine.

The following temperature chart shows a typical short wave of fever such as is usually seen when a monkey is inoculated with the *Micrococcus melitensis* subcutaneously.

MONKEY 5.



Remarks.—After an interval of about 24 days from the commencement of the feeding the monkey suffered from a typical attack of Mediterranean Fever. The distribution of the *Micrococcus melitensis* in the body was somewhat peculiar, the mesenteric and systemic lymphatic glands being densely crowded with the *Micrococcus melitensis*, while the spleen only showed four colonies.

Experiment II.—Monkey No. 4, brought from Calcutta, was placed in a mosquito-proof chamber in the Lazaretto, Malta.

1905—

July 26. Examined blood; serum gave no reaction with the *Micrococcus melitensis*.

,, 28. Fed on mixed milk obtained from the same goats as were used in Experiment I. The same method of feeding was followed as with Monkey No. 5, and was continued from this date until a distinct blood reaction was obtained.

Aug. 4. Examined blood; no reaction obtained.

,, 13. Examined blood; no reaction obtained.

,, 16. Examined blood; no reaction obtained.

,, 21. Examined blood; no reaction obtained.

,, 28. Blood serum, in dilutions of 1/10 and 1/40, gave a complete reaction with the *Micrococcus melitensis*, visible with the naked eye in five minutes.

,, 31. Removed 0·5 c.c. of blood from a saphenous vein and planted out in broth-tubes. After seven days' incubation at 37° C. no growth was obtained.

Sept. 1. Removed 2 c.c. of blood and planted in broth-tubes. After seven days' incubation at 37° C. no growth was obtained.

1905—
Sept. 3. Blood serum diluted 1/50 gave an immediate reaction.
„ 9. Removed 1 c.c. of blood and planted in broth-tubes. After seven days' incubation at 37° C. no growth was obtained. Blood serum, diluted 1/500, gave an immediate reaction with the *Micrococcus melitensis*.
„ 16. Removed 2 c.c. of blood and planted in broth-tubes. After seven days' incubation at 37° C. no growth was obtained.
„ 21. Killed monkey with chloroform.

Post-mortem Examination.—Body well nourished; spleen enlarged, soft and friable in consistence; liver very congested; kidneys congested; axillary and femoral glands enlarged; mesenteric glands not enlarged. Cultures were made as follows:—

Spleen.—Planted out on 12 agar slopes and in broth-tubes.

Liver.—Planted out on 12 agar slopes and in broth-tubes.

Kidney.—Planted out on 12 agar slopes and in broth-tubes.

Heart's Blood.—Planted out in broth.

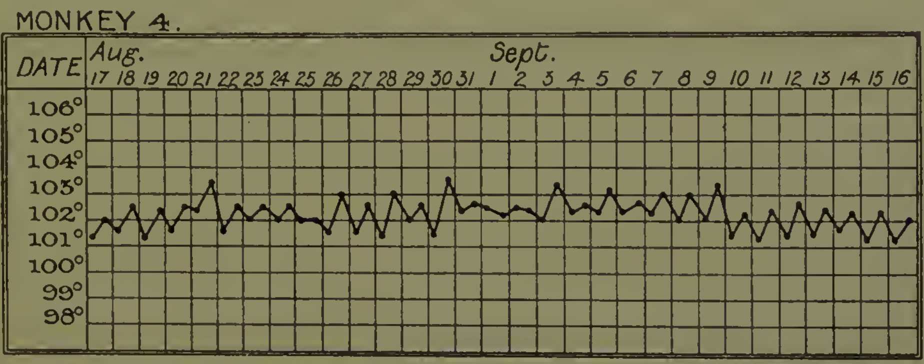
Bile.—Planted out on the surface of glucose-nutrose-agar plates.

Artillery Glands.—Sections made and then rubbed over glucose-nutrose-agar plates.

Femoral Glands.—Sections made and then rubbed over glucose-nutrose-agar plates.

Mesenteric Glands.—Sections made and then rubbed over glucose-nutrose-agar plates.

After four days' incubation at 37° C. only 15 colonies were found on the agar slopes inoculated from the spleen. The liver and kidney cultures were sterile, and no signs of the *Micrococcus melitensis* were observed on the plates made from the bile and axillary glands. Numerous colonies, however, were found in the plates made from the femoral and mesenteric glands. The following chart shows the temperature of the monkey during the experiment:—



Remarks.—After an interval of 33 days from the commencement of feeding this monkey became infected, but there was never any wave of fever as in Experiment I. The distribution of the *Micrococcus* *melitensis* in the body was similar to that observed in the first experiment.

Experiment III.—Monkey No. 2 was brought from Calcutta, and placed in a mosquito-proof chamber in the Lazaretto, Malta.

1905—
July 26. Examined blood; serum gave no reaction with the *Micrococcus melitensis.*
,, 27. Fed on mixed milk as in Experiments I and II.
,, 28 to Aug. 3. Feeding continued.
Aug. 4. Examined blood; no reaction obtained.
,, 4 to 12. Feeding continued.
,, 13. Examined blood; no reaction obtained.
,, 13 to 23. Feeding continued.
,, 24. Examined blood; no reaction obtained.
,, 24 to 27. Feeding continued.
,, 28. Examined blood; no reaction obtained.
,, 28 to Sept. 2. Feeding continued.
Sept. 3. Examined blood; no reaction obtained.
,, 3 to 7. Feeding continued.
,, 8. Examined blood; no reaction obtained.
,, 8 to 17. Feeding continued.
,, 18. Examined blood; no reaction obtained.
,, 18 to 23. Feeding continued.
,, 24. Examined blood; no reaction obtained.
,, 24 to 27. Feeding continued.
,, 28. Examined blood; no reaction obtained.
,, 28 to Oct. 2. Feeding continued.
Oct. 3. Examined blood; no reaction obtained.
,, 4 to 8. Feeding continued.
,, 9. Examined blood; a slight reaction obtained after two hours.

From this date the blood was examined weekly, but a definite reaction was not obtained again. The monkey died suddenly on Oct. 18. At the *post-mortem* examination a localised abscess was found round the sigmoid flexure. The organs appeared healthy. Cultures were made from the spleen, glands, and heart's blood. The *Micrococcus melitensis* was isolated from the spleen and glands.

A specimen of blood obtained at the *post-mortem* was tested for agglutination. A dilution of 1/10 gave an incomplete reaction.

Remarks.—During life the monkey suffered from a wave of fever which was attributed to an infection with the *Micrococcus melitensis*, but the *post-mortem* examination showed that the febrile condition might have been due to the abscess round the sigmoid flexure. Although a specific infection undoubtedly occurred, as shown by the isolation of the *Micrococcus militensis* from the spleen and glands, the blood serum only once during life caused complete agglutination of the *Micrococcus melitensis*, and that only in a dilution of 1/10.

Experiment IV.—Monkey No. 99 was brought from Calcutta and placed on the terrace of the Public Health Department, Valletta :—

1905—
June 21. Examined blood; no reaction obtained.
,, 26. Examined blood; no reaction obtained. Fed on milk from infected Goat No. 2.
,, 27. Fed on milk from infected Goat No. 2.
July 2. Examined blood; no reaction obtained.
,, 9. Examined blood; no reaction obtained.
,, 16. Examined blood; no reaction obtained.
,, 22. Examined blood; no reaction obtained.
,, 23. Fed on mixed milk obtained from infected herds at Pieta and Hamrun.
,, 24 to 28. Feeding continued.
,, 29 to Aug. 8. Fed on mixed milk obtained from the infected goats in the Lazaretto.
Aug. 6. Examined blood; no reaction obtained.
,, 15. Examined blood; no reaction obtained.
,, 16 to 21. Fed on milk from infected Goat No. 37.
,, 22. Monkey suffering from diarrhœa. Feeding discontinued.
,, 23. Examined blood; no reaction obtained.
,, 24 to 29. Fed on milk from Goat No. 37.
,, 30. Examined blood; slight reaction with serum diluted 1/10.
Sept. 3. Examined blood; distinct reaction after half an hour, serum diluted 1/10.
,, 5. Examined blood; serum diluted 1/100 reacted at once, and diluted 1/300 reacted in half an hour.
,, 9. Removed 2 c.c. of blood from a saphenous vein and planted out in broth-tubes. After seven days' incubation at 37° C. no growth obtained.
,, 17. Removed 2 c.c. of blood and treated as on the 9th; no growth obtained.
,, 25. Killed monkey with chloroform.

Post-mortem Examination.—Fairly nourished; axillary and femoral glands very large, mesenteric glands enlarged; spleen large, soft and friable; liver very congested.

Cultures were made as follows :—

Spleen.—Planted out on agar slopes and in broth-tubes.

Liver.—Planted out on agar slopes and in broth-tubes.

Kidney.—Planted out on agar slopes and in broth-tubes.

Heart's Blood.—Planted out in broth-tubes.

Bile.—Planted out on the surface of the glucose-nutrose-agar plates.

Femoral Glands.—Sections made and then rubbed over glucose-nutrose-agar plates.

Axillary Glands.—Sections made and then rubbed over glocose-nutrose-agar plates.

Mesenteric Glands.—Sections made and then rubbed over glucose-nutrose-agar slopes.

After four days' incubation at 37° C. the *Micrococcus melitensis* was recovered from the plates made from the mesenteric glands.

Remarks.—A blood reaction pointing to the infection was not obtained until about 70 days from the commencement of feeding. The monkey never suffered from fever, but the high dilution in which the blood serum reacted and the presence of the *Micrococcus melitensis* in the mesenteric glands showed that a true infection had taken place.

To Determine the Possibility of Infecting a Goat by Feeding on Infected Milk.

Goat No. 8.—This goat had been in the Lazaretto for two months before the experiment was commenced:—

1905—

June 27. Examined blood; no reaction obtained.

,, 29. Fed on mixed milk obtained from infected goats in the Lazaretto.

July 1. Fed as on the 29th.

,, 8. Examined blood; no reaction obtained.

,, 13. Removed 10 c.c. of milk from udder, centrifugalised specimen, and plated deposit on glucose-nutrose-agar plates. No signs of the *Micrococcus melitensis* detected.

,, 28. Examined blood; no reaction obtained.

,, 29 to August 24. Fed three times a day on mixed milk derived from the infected goats in the Lazaretto.

Aug. 4. Examined blood; no reaction obtained.

,, 13. Examined blood; no reaction obtained.

,, 22. Examined blood; no reaction obtained.

Sept. 26. Examined blood; no reaction obtained.

Oct. 7. Examined blood; serum diluted 1/10 gave an incomplete reaction.

,, 9. Examined blood; serum diluted 1/10 gave an immediate reaction, visible with the naked eye. Removed 5 c.c. of blood from the jugular vein and planted out in broth-tubes; after seven days' incubation at 37° C. no growth obtained. Drew off 10 c.c. milk, centrifugalised specimen, and planted out deposit on glucose-nutrose-agar plates. No signs of *Micrococcus melitensis* detected.

1905—
Oct. 18. Examined blood; serum diluted 1/10 gave an incomplete reaction.
„ 23. Milk centrifugalised and deposit plated; *Micrococcus melitensis* not recovered.
„ 25. Blood serum diluted 1/10 gave an incomplete reaction.
„ 30. Milk examined as on the 23rd. *Micrococcus melitensis* not recovered.
Nov. 30. The *Micrococcus melitensis* has not yet appeared in the milk. The goat is still under observation.

To Test the Possibility of Infecting a Kid by Feeding on Infected Milk.

Kid No. 9.—This kid was under observation for about two months before this experiment was commenced. The blood was repeatedly examined, but no reaction could be obtained with the *Micrococcus melitensis.* It was placed in a room quite apart from the infected goats :—

1905—
July 13. Examined blood; no reaction obtained. Commenced feeding with milk obtained from infected goats in the Lazaretto.
„ 14 to 27. Fed once a day on the infected milk.
„ 28 to August 28. Fed three times a day on the infected milk.
July 22. Examined blood; no reaction obtained.
„ 30. Examined blood; no reaction obtained.
Aug. 7. Examined blood; no reaction obtained.
„ 13. Examined blood; no reaction obtained.
„ 21. Examined blood; no reaction obtained.
„ 27. Examined blood; no reaction obtained.
Sept. 5. Examined blood; no reaction obtained.
„ 14. Examined blood; no reaction obtained.
„ 26. Examined blood; dilution 1/10 reacted at once, clumps visible with naked eye.
Oct. 8. Examined blood; dilution 1/10 gave an immediate reaction, dilution 1/20 "nil."
„ 31. Killed the kid and made cultures from the spleen, kidneys, liver, glands, and blood from the inferior vena cava. The *Micrococcus melitensis* was not recovered from any of the organs.

Remarks.—Though a blood reaction was obtained, a true infection did not appear to have taken place. Three other kids fed in the same manner are still under observation.

Feeding with Infected Milk and also with Culture Isolated from Spleen of Man.

Goat No. 4.—This goat was kept under observation for three months before the experiment was commenced. Its blood was repeatedly examined, but never showed the slightest reaction with the *Micrococcus melitensis.* Milk was removed on several occasions, and the deposit obtained by centrifugalisation plated; no signs of the specific micrococcus were observed. On June 27 the goat was fed on infected milk obtained from Goat No. 2. On June 28 mixed milk, obtained from an infected herd, was given. Feeding with this milk was continued until August 16. The blood serum was examined weekly during June, July, and August, but never showed the slightest power of agglutinating the *Micrococcus melitensis.* On September 4 the goat was fed with an emulsion in water of an agar growth of the *Micrococcus melitensis* isolated from the spleen of man. This feeding was continued every other day until the growth of *Micrococcus melitensis* on six agar slopes had been consumed. Examination of the blood for agglutinating reaction, and of the milk for the *Micrococcus melitensis,* was continued weekly. On October 6 the blood serum, diluted 1/10, was found to give an immediate reaction with the *Micrococcus melitensis.* On October 8, 5 c.c. of blood were removed from the jugular vein, and planted out in broth-tubes. After seven days' incubation at 37° C. the broth-tubes were found to be sterile. On October 8 blood was again removed from the jugular vein, but the *Micrococcus melitensis* was not recovered. On October 18 the blood reaction was found to be the same as on the 6th of that month; dilutions above 1/10 failed to give any reaction. On the 23rd, 10 c.c. of the milk were centrifugalised, and the deposit plated; the *Micrococcus melitensis* was recovered in small quantity. On October 30 the *Micrococcus melitensis* was found in considerable quantity in the milk. On November 2 the blood serum, diluted 1/20, gave a reaction with the *Micrococcus melitensis.* On November 3 the milk became scanty and thin and serous in character; the microbe could no longer be isolated from it. On November 6 the milk secretion was almost arrested, and on the 13th it had disappeared completely. On November 9 the blood reaction was found to have risen slightly, a dilution of 1/40 causing a complete agglutination of the *Micrococcus melitensis.*

Remarks.—The excretion of the *Micrococcus melitensis* in the milk did not take place until 50 days after the first feeding with the agar culture derived from the spleen of man, and persisted for only three days.

III. To Determine the Mode in which Goats become Infected.

It appeared possible that goats might become infected—

(*a*) By feeding on infected dust.
(*b*) By feeding on infected milk.
(*c*) By inoculation through the agency of infected mosquitos.
(*d*) By inoculation through the agency of infected blood-sucking flies.
(*e*) By direct transmission from mother to kid.

(a) *To Determine the Possibility of Infecting Goats by Feeding them on Infected Dust.*

Goat No. 13.—This goat was in full milk when bought. It was taken to the Lazaretto and placed in a room quite apart from the infected goats. Before the experiment was commenced the blood was repeatedly examined, but no signs of a reaction were observed. On July 13 dust, infected with goat's urine containing the *Micrococcus melitensis* and then dried, was sprinkled over the food. This was done daily until July 22, when dust infected from a case of Mediterranean Fever was used. This dust, dried for 24 hours at room temperature, was sprinkled over the food for a further period of three weeks. The blood was tested weekly for a reaction with the *Micrococcus melitensis*, and on August 3 the blood serum, diluted 1/10, was found to give an instantaneous reaction. The examination of the blood was continued, but the serum reaction never rose above a dilution of 1/10. Five cubic centimetres of blood were removed once a month from the jugular vein, but the *Micrococcus melitensis* was not isolated.

Every week 10 c.c. of the milk were centrifugalised, and the deposit plated. On October 16 the *Micrococcus melitensis* was isolated from the milk. No rise of temperature was ever observed. The goat is still under observation.

Remarks.—This experiment proves that a goat can be infected by feeding on dust infected with urine from Mediterranean Fever patients. The excretion of the *Micrococcus melitensis* in the milk appears to be a late phenomenon, as it was not seen until 74 days after the blood reaction.

Goat No. 14.—This experiment was conducted on the same lines as the one just described. The dust, however, was often slightly moist, instead of being thoroughly dried as in the case of Goat No. 13. The feeding was commenced on July 20, and continued until September 1. The blood was tested weekly for a reaction with the *Micrococcus* *melitensis.* On September 3 the blood serum, diluted 1/10, gave a distinct reaction. On October 2 the blood serum, diluted 1/20, caused instantaneous clumping of the *Micrococcus melitensis*, but on October 24 the working dilution was only 1/10. Every week 10 c.c. of the milk were centrifugalised, and the deposit plated, but up to the present the microbe has not appeared in the milk. The goat is still under observation.

Remarks.—As the dust was imperfectly dried, it was thought that Goat No. 14 would have been more seriously affected that Goat No. 13, and it was expected that the *Micrococcus melitensis* would appear in the milk at an earlier date.

(b) *To Determine the Possibility of Infecting Goats and Kids by Feeding them on Infected Goat's Milk.*

It is the custom to feed young kids on milk, and this mode of infection appeared probable, but whether the infection so acquired will persist until the adult stage can only be proved by keeping the animals under observation for a prolonged period.

The histories of Goat No. 8 and Kid No. 9 show that a blood reaction may be acquired in this manner. Goat No. 8 is still under observation. Kid No. 9 was killed, but the *Micrococcus melitensis* was not isolated from its organs, so a true infection did not appear to have taken place in this case.

Five other kids have been fed on infected milk, and are being kept under observation.

(c) *To Determine the Possibility of Infecting Goats through the Agency of Mosquitoes.*

In another section of this report we have shown that *Culex pipiens* and *Stegomyia fasciata* may carry the *Micrococcus melitensis*, consequently it appeared desirable to test by actual experiment whether the microbe could be conveyed from an infected to a healthy goat through their agency.

Culex pipiens, *Stegomyia fasciata*, and *Acartomyia Zammitii* were bred from larvæ. About 50 imagos of each kind were placed in separate cages and fed on the goats from whose blood Zammit had previously recovered the *Micrococcus melitensis.* The cages were transferred to the healthy goats after periods which varied in each series of experiments. In the first series the interval between the feeding on the infected and healthy goats was 48 hours, in the second series the interval was 72 hours. Forty-eight hours after feeding on the healthy goats the mosquitoes were again transferred to the infected goats. The blood of each healthy goat employed in the experiments was tested twice a week for a reaction with the *Micrococcus melitensis.* The experiments were continued for two months. It was found that on an average the mosquitoes only lived for about 14 days, so fresh batches had to be employed as the old ones died off.

The healthy goats never showed the slightest sign of a blood reaction with the *Micrococcus melitensis*.

In these experiments the cages could not be fastened to the goats for a longer period than two hours, as the animals struggled violently when kept in one position for a longer time. It was thought that the failure might have been due to an unsuitable selection of the intervals between the various feedings, and to the comparatively short time that the mosquitoes were in actual contact with the animals.

An attempt was now made to imitate the conditions actually occurring in daily life. A small recess in one of the large rooms in the Lazaretto was divided into two compartments, each large enough to hold a goat comfortably, by means of a partition made of coarse wire netting fastened below to a board 3 feet in height. The board was fixed to the floor of the recess by cement, so that urine could not possibly pass from the infected to the healthy goat. The top and front of the recess were made mosquito proof, and a small mosquito-proof door was provided for each compartment. Brackets were fastened on the walls of each compartment out of reach of the goats. Jars containing water full of larvæ in the pupal stage were then placed on the brackets in the compartment containing the infected goat, and jars containing water free from larvæ were placed on the brackets in the compartment for the healthy goat. The wooden portion of the partition prevented the goats coming into actual skin contact, but the large apertures in the wire netting readily permitted the mosquitoes to fly from one compartment to the other. This experiment was continued for a month, fresh water containing larvæ being placed in the compartment containing the infected goat as the imagos died off. At a later period imagos were bred out in cages and then let loose in the infected compartment. The blood of the healthy goat was examined twice a week, but it never showed the slightest sign of a reaction with the *Micrococcus melitensis*. The goat is still under observation.

Result.—Up to the present time infection has not been conveyed to healthy goats by means of mosquitoes which had previously fed on infected goats. The failure of the experiments may be due to the *Micrococcus melitensis* being present in the blood of infected goats in too small quantity to be conveyed by mosquitoes. In the feeding experiments already described 5 c.c. of blood were frequently taken from the jugular vein of infected goats, and yet the *Micrococcus melitensis* was never isolated. Zammit succeeded in isolating the *Micrococcus melitensis* from the blood of the infected goats used in the experiments once only, all his further attempts failed.

Knowing how intimately goats live with the Maltese people, it seems probable that, if mosquitoes do convey infection to goats, the infecting microbe is obtained from man and not from the goat.

(d) *To Determine the Possibility of Infecting Goats through the Agency of Blood-sucking Flies.*

Stomoxys calcitrans having been noticed to infest the goats in Malta, it was thought that this fly might act as an infecting agent. Cages containing about 50 of these flies were placed on the infected goats used in the mosquito experiments, and then transferred after varying periods to a healthy goat. It was soon noticed, however, that unless the flies were fed every 48 hours a very heavy mortality took place. Accordingly the interval between the feedings was mainly kept to this period. The flies fed extremely well on the goats, and their bodies were noticed to be distended with blood. The healthy goat's blood was examined twice a week, but no sign of a reaction with the *Micrococcus melitensis* was ever obtained. The experiments were continued for two months, fresh batches of flies being employed as the old ones died off.

Result.—Up to the present infection has not been conveyed to healthy goats by *Stomoxys calcitrans* which had been previously fed on infected goats. The cause of failure may be that suggested in the mosquito experiments. *Stomoxys* will bite man, and it may be that infection is conveyed from man to goat by its means.

The *Micrococcus melitensis* has not yet been isolated from *Stomoxys* fed on goats and monkeys, and on humanitarian grounds it has not been possible to feed the flies, which produce much swelling and irritation, on patients suffering from Mediterranean Fever.

(e) *To Test the Possibility of Direct Transmission of Infection from Mother to Kid.*

When the herd of goats at Pieta was being examined, it was noticed that one of them (No. 19) was pregnant. The goat only gave one pint of milk, which was normal in appearance, and was used for feeding the kids attached to the herd. The blood of the goat was examined, and it was found that the serum, diluted 1/100, caused immediate agglutination of the *Micrococcus melitensis*. The animal was then purchased, and brought to the Lazaretto on July 16. On July 17 10 c.c. of the milk were centrifugalised, and the deposit spread on glucose-litmus-nutrose-agar plates. After four days' incubation at 37° C., all the plates were found densely crowded with colonies of the *Micrococcus melitensis*. The milk was examined weekly until October 23, and on each occasion a rich growth of the microbe was obtained. On August 14 and September 14, 5 c.c. of blood were removed from the jugular vein and planted out in broth-tubes. On both occasions the tubes were found quite sterile after 10 days' incubation. On October 25 it was noticed that the blood reaction had diminished, a dilution of 1/50 producing complete agglutination, but 1/100 merely produced a few small clumps. On the afternoon of October 25 the goat dropped her kid, which was a male, and quite strong and healthy, it was numbered 19A. On October 27, 5 c.c. of blood were taken from the jugular vein of the goat, but the *Micrococcus melitensis* was not recovered. The milk was examined on the same day, and found to be teeming with the specific *Micrococcus melitensis.* On October 30 and November 3 the milk was examined again, but no traces of the *Micrococcus melitensis* could be discovered. On November 2 the blood reaction was tested again, and it was found that the serum, diluted 1/125, caused complete agglutination, and small clumps were produced by a dilution of 1/200. On November 13 the serum, diluted 1/200, caused a complete reaction. At the end of November the *Micrococcus melitensis* again appeared in the milk.

Kid (19A) dropped by Goat No. 19 on October 25. On October 26 the blood was tested for agglutination, and it was found that the serum, diluted 1/50, caused an immediate complete reaction, whilst a dilution of 1/100 only produced a few small clumps. It was noticed that the blood reaction corresponded exactly to that of the mother on the day the kid was born. On November 4 the blood reaction was found unchanged, but on November 13 a dilution of only 1/20 was found capable of producing a complete agglutination of the *Micrococcus melitensis.* The kid was then killed and cultures were made from the organs. The *Micrococcus melitensis* was not isolated.

Remarks.—This experiment appears to prove that agglutinins are transferred *in utero* from mother to kid. It also shows that pregnancy may progress in a perfectly normal manner when the mother is markedly infected. The suppression of the excretion of *Micrococcus melitensis* in the milk for nearly a month after the birth of the kid is interesting.

IV.—EXPERIMENTS TO DETERMINE WHETHER IT IS POSSIBLE TO DESTROY THE *Micrococcus melitensis* BY PASTEURISATION OF THE INFECTED MILK.

Experiment I.—Milk was drawn from goats 1, 2, 3, 5 and 6 and thoroughly mixed. This mixed milk was selected for experiment as it contained thick ropy masses, and it was thought that these might act as protecting envelopes to the specific micrococci, so that if such a milk were sterilised by Pasteurisation, it might safely be concluded that any ordinary normal looking milk would be equally sterilised by the same operation.

One loopful of the mixed milk was stroked on a series of surface plates to act as a control. The mixed milk was then heated on a water-bath to 68° C. and this temperature was maintained for 10 minutes. The milk was then rapidly cooled and 10 c.c. of the sterilised milk were spread over 20 litmus-nutrose-agar plates.

Results.—After four days' incubation at 37° C. the control plates were found densely crowded with colonies of the *Micrococcus melitensis*; the plates made from the Pasteurised milk remained free from any signs of the specific *Micrococcus melitensis*, even though the incubation was continued for 14 days.

Experiment II.—This served as a control of Experiment I, the same procedure being followed. The *Micrococcus melitensis* appeared in the control plates, but the plates made with the Pasteurised milk again remained perfectly sterile.

Summary.

1. Judged by the serum reaction, 41 per cent. of the goats in Malta are infected.

2. Ten per cent. of the goats supplying milk to various parts of Malta appear to excrete the *Micrococcus melitensis* in the milk.

3. The excretion of the specific microbe may continue steadily for three months without any change occurring in the physical character or chemical composition of the milk, and without the animal exhibiting any signs of ill health.

4. Some infected goats may lose flesh and their coats may become thin; they may also suffer from a short hacking cough. A febrile condition, however, has not been observed.

5. Goats may have a marked blood reaction (1/100), and yet never excrete the *Micrococcus melitensis* in the milk.

6. If the blood serum or milk does not agglutinate the *Micrococcus melitensis*, the specific microbe is not found in the milk.

7. There is no constant relation between the amount of agglutinins in the milk or blood, and the excretion of *Micrococcus melitensis* in the milk; but the higher the dilution of the serum which agglutinates the *Micrococcus melitensis*, the greater is the probability of finding the *Micrococcus melitensis* in the milk.

8. The excretion of the *Micrococcus melitensis* in the milk may be intermittent, appearing for a few days and then disappearing for a week or more.

9. A blood reaction may exist for some weeks before the *Micrococcus melitensis* is excreted in the milk.

10. If blood cannot be obtained the milk reaction with the *Micrococcus melitensis* (Zammit's test) is a good indication of infection.

11. The milk agglutination test is a surer indication of the *Micrococcus melitensis* being excreted in the milk than the serum reaction.

12. Monkeys and goats can be infected by feeding with cultures of *Micrococcus melitensis* isolated from milk, and also by feeding with infected milk itself.

13. The incubation period in feeding experiments appears to vary between three and four weeks.

14. Monkeys infected by feeding sometimes suffer from a typical wave of fever and lose flesh, at other times they show no obvious signs of ill health, and may even gain in weight.

15. When monkeys become infected by feeding with milk, the lymphatic glands always contain far more colonies of the *Micrococcus melitensis* than the spleen. This fact suggests that the specific micrococci contained in the food are carried to the lymphatic glands and there undergo considerable multiplication. It has not yet been proved that the mesenteric glands are always infected at an earlier date than the femoral and axillary glands, but Experiment IV, feeding with milk, shows that this may be the case at times.

16. It has been demonstrated that goats may become infected by feeding on dust polluted with urine from cases of Mediterranean Fever. The excretion of *Micrococcus melitensis* in the milk resulting from such infection, is a late phenomenon, only appearing about 74 days after the blood reaction has developed.

17. It has not been possible yet to convey infection from goat to goat by means of mosquitoes or *Stomoxys calcitrans*. If mosquitoes do carry the infection, it seems more probable that the microbe is transferred from man to goat, than from goat to goat.

18. Agglutinins may be transferred from the mother to the fœtus *in utero*. Pregnancy appears to follow a normal course in infected goats.

19. Pasteurisation (68° C. for 10 minutes) destroys the *Micrococcus melitensis* present in infected goat's milk.

VII.—MOSQUITOES AS A MEANS OF DISSEMINATION OF MEDITERRANEAN FEVER.

By Major W. H. Horrocks, R.A.M.C., and Captain J. C. Kennedy, R.A.M.C.

(Received December 16, 1905.)

(Plate 2.)

Epidemiological inquiries having shown that while the consumption of infected milk may, and probably does, account for much of the Mediterranean Fever amongst the Maltese, yet many cases occur among the military and naval populations in Malta which cannot be attributed to this cause. Accordingly, a study of mosquitoes as possible carriers of the *Micrococcus melitensis* was commenced. The work done may be arranged in three parts :—

Part I.—A study of the species of mosquitoes found in Malta, and their distribution in the island.

Part II.—Examination of the species to determine whether any of them act as carriers of the *Micrococcus melitensis.*

Part III.—Experiments to determine whether any of the species are capable of conveying infection from cases of Mediterranean Fever occurring in man to healthy monkeys, or from infected to healthy monkeys.

Part I.—Study of the Species of Mosquitoes Found in Malta.

Mosquitoes were caught in the Military Hospital, Valletta; Military Hospital, Cottonera; Military Hospital, Citta Vecchia; Military Hospital, Imtarfa; Fort Chambray, Gozo; Military Hospital, Forrest Hill; Floriana Barracks; Civil Hospital, Floriana; Naval Hospital, Bighi; Fort Ricasoli; Barracks, Lower St. Elmo; Sliema; Birchircara; Barracks Imtarfa; Barracks Cottonera. The following species were recognised :—

Culex pipiens.
Culex fatigans.
Culex spathipalpis.
Stegomyia fasciata.
Acartomyia Zammitii.

All the species, except *Culex spathipalpis*, were found at times full of blood. *Acartomyia Zammitii* and *Stegomyia fasciata* attack human beings both day and night. Whilst *Culex pipiens* and *Culex fatigans* only become troublesome at night.

The distribution of the mosquitoes found was chiefly as follows:—

- Military Hospital, Valletta—
  - *Culex pipiens.*
  - *Culex fatigans* (very few).
  - *Acartomyia Zammitii* } These are very rare after the end of September.
  - *Stegomyia fasciata* }
- Military Hospital, Cottonera—
  - *Culex pipiens.*
  - *Culex fatigans.*
  - *Culex spathipalpis.*
  - *Acartomyia Zammitii.*
  - *Stegomyia fasciata.*
- Military Hospital, Citta Vecchia—
  - *Culex pipiens.*
  - *Culex spathipalpis* } Comparatively rare.
  - *Stegomyia fasciata* }
- Military Hospital, Imtarfa—
  - *Culex pipiens* (very common).
  - *Culex spathipalpis* (rare).
- Fort Chambray, Gozo—
  - *Culex pipiens.*
  - *Culex fatigans.*
  - *Acartomyia Zammitii.*
- Floriana Barracks—
  - *Culex pipiens.*
- Civil Hospital, Floriana—
  - *Culex pipiens.*
  - *Culex fatigans.*
  - *Stegomyia fasciata.*
- Ricasoli Fort—
  - *Culex fatigans.*
  - *Culex pipiens.*
  - *Acartomyia Zammitii.*
  - *Stegomyia fasciata.*
- Lower St. Elmo Barracks—
  - *Culex pipiens.*
  - *Acartomyia Zammitii.*
  - *Stegomyia fasciata.*

The *Acartomyia Zammitii* breeds in the salt pools found close to the sea, and it appeared important to determine whether this mosquito invades the small towns and barracks in the interior of the island. More than 600 mosquitoes were collected from Citta Vecchia and Imtarfa, and yet *Acartomyia Zammitii* was never found once among them. Severe outbreaks of Mediterranean Fever having occurred at both these places, the distribution indicates that, even if Mediterranean Fever be a mosquito-borne disease, the probabilities are against *Acartomyia Zammitii* being an important infecting agent.

The seasonal prevalence of the mosquitoes is also interesting in view of the fact that cases of Mediterranean Fever occur amongst the military and naval garrison during the winter months. Looking at the question from this point of view the *Culex pipiens* would appear to be likely to play an important part in conveying infection.

PART II.—EXAMINATION OF MOSQUITOES TO DETERMINE WHETHER ANY SPECIES ACT AS CARRIERS OF THE *Micrococcus melitensis*.

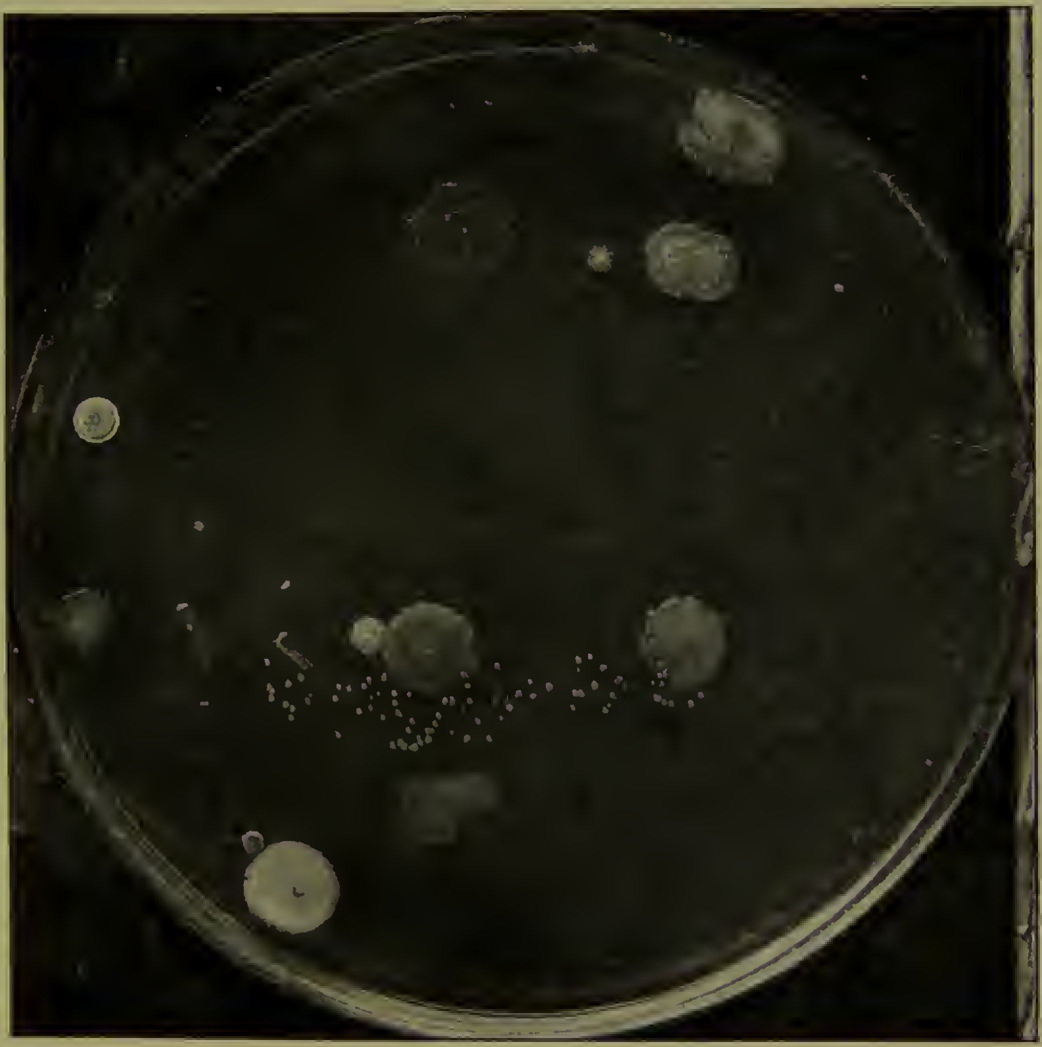
The following procedure was adopted in the examination of mosquitoes. Specimens full of blood were caught in boxes and stupified with chloroform. Each mosquito was then placed on a sterile glass slide, and needles being placed on the thorax and penultimate segment of the abdomen, gentle traction was exerted. With a little practice it was found possible to completely separate the parts, and leave the coagulated blood on the slide practically free from all contaminating fluids contained in the body of the mosquito. A few drops of sterile water were now added to the blood, and the whole was thoroughly mixed. The fluid was then drawn up in a sterile pipette, and transferred to litmus-nutrose-glucose-agar plates, and carefully spread over the surface of the medium. The plates were then incubated at 37° C., and examined in the usual way at the end of four days.

The first recovery was made on September 4 by one of us (H) from a mosquito (*Culex pipiens*) caught full of blood in the Lazaretto. One plate made in the manner described above contained 34 colonies of the *Micrococcus melitensis*. The micro-organism recovered was subjected to the most rigorous tests, and its pathogenicity was proved by injecting the growth on an agar slope obtained from one of the colonies on the plate (see Monkey C).

The second recovery was made on September 15 (by K) from a *Stegomyia fasciata* caught full of blood in the Mediterranean Fever wards of the Military Hospital, Valletta. One plate contained 24 colonies of the *Micrococcus melitensis*. The pathogenicity of this culture was also tested (see Monkey 101).

The third recovery was made (by H) on September 23 from a *Culex pipiens* caught in the Mediterranean Fever ward at the Naval Hospital, Bighi (Plate 2). The plate contained 100 colonies of the *Micrococcus melitensis*.

The fourth recovery was made (by H) on September 24 from a *Culex pipiens* caught in the Civil Hospital, Florian. The plate in this case only contained four colonies of the *Micrococcus melitensis*.



Blood from the stomach of a *Culex pipiens* caught in the Naval Hospital, Bighi, Malta. Plated on glucose-nutrose-litmus-agar. Incubated for 4 days at 37° C.

From photo. by Staff-Sergeant Rossiter, R.A.M.C.

It was noticed that, though several plates were inoculated with the blood from the mosquito, all the colonies on each occasion appeared in one plate.

Bearing in mind the work done by Shaw, Zammit, and Gilmour on the blood of patients suffering from Mediterranean Fever, the number of colonies which appeared to be present in the small quantity of blood contained in the mosquitoes is very remarkable, and suggests that either the *Micrococcus melitensis* undergoes multiplication in the mosquito, or else the micrococci are phagocyted in corpuscles which are broken up by the manipulations on the glass slide.

The following tables show the number and species of the mosquitoes which have been dissected up to the present time :—

Table A (Mosquitoes dissected by H.).

	Culex pipiens.	*Culex fatigans.*	*Stegomyia fasciata.*	*Acartomyia Zammitii.*	Total.
Military Hospital, Valletta	6	0	3	11	20
Civil Hospital, Floriana	63	0	24	0	87
Naval Hospital, Bighi	13	0	7	5	25
Military Hospital, Citta Vecchia	93	0	2	0	95
Military Hospital, Imtarfa	6	0	0	0	6
Barrack Room, Citta Vecchia	8	0	0	0	8
Military Hospital, Forrest	4	0	2	0	6
Military Hospital, Cottonera	13	0	0	0	13
Barracks, St. Andrews	4	0	0	0	4
Barracks St. Elmo……	0	0	3	0	3
Lazaretto, Manoel ……	3	0	1	0	4
Barracks, Floriana……	4	0	0	0	4
Total………	217	0	42	16	275

Three recoveries of *Micrococcus melitensis* were made out of 275 mosquitoes dissected. It should be noted, however, that 95 mosquitoes were collected at Citta Vecchia, where the cases of Mediterranean Fever are mostly chronic, Citta Vecchia being a kind of sanatorium for the acute cases treated in Valletta and Cottonera. There were also few acute cases in the Civil Hospital, Floriana, at the time when the 87 mosquitoes were collected there.

Table B (Mosquitoes dissected by K. up to end of October, 1905).

Hospital.	*Culex pipiens.*	*Culex fatigans.*	*Stegomyia.*	*Acartomyia.*	Total.
Military Hospital, Valletta	109	3	45	32	189
Cottonera	5	1	—	—	6
Citta Vecchia............	159	—	1	—	160
Imtarfa	20	—	—	—	20
Civil Hospital, Valletta	40	–	14	—	54
Naval Hospital, Bighi	2	—	—	—	2
Total.........	335	4	60	32	431

The mosquitoes in Table B were all captured in wards containing Mediterranean Fever patients.

Out of the total of 431 from these infected places, only one was found to contain *Micrococcus melitensis*. This was a *Stegomyia*, caught in 20A Ward, Valletta Military Hospital, on September 15. Twenty-four colonies of the microbe were obtained from the stomach.

Table C.—Mosquitoes caught in places where there were presumably no Mediterranean Fever Patients (dissected by K. up to the end of October).

Place.	*Culex pipiens.*	*Culex fatigans.*	*Culex Spathipalpis.*	*Stegomyia.*	*Acartomyia.*	Total.
Military Hospital, Valletta	58	1	—	9	4	72
Military Hospital, Cottonera	8	1	—	1	—	10
Military Hospital, Imtarfa	6	—	1	—	—	7
Military Hospital, Citta Vecchia	44	—	—	—	—	44
Military Hospital, Forrest	4	1	—	4	3	12
Floriana Barracks	9	--	—	—	—	9
Lower St. Elmo Barracks	6	—	—	3	13	22
Fort Ricasoli	7	1	—	2	1	11
Gozo	—	—	—	—	1	1
Valletta	1	—	—	1	—	2
Total	143	4	1	20	22	190

No *Micrococcus melitensis* was recovered from any of these.

The *Micrococcus melitensis* was only recovered from four out of a total of 896 mosquitoes dissected. It must, however, be noted that some 255 mosquitoes were obtained from Citta Vecchia, where the cases of Mediterranean Fever are mostly chronic, and about 200 other mosquitoes were caught in places where there were no known cases of Mediterranean Fever. Deducting these numbers from the total, the result would be four infected mosquitoes out of about 450 mosquitoes collected in presumably infected places.

This result was not unexpected; considering the small numbers of the specific micrococci which are found in the peripheral blood of Mediterranean Fever patients, mosquitoes could not possibly be infected in great numbers, or Mediterranean Fever would be much more prevalent than it is at present.

Experiments to Test the Virulence of the Micrococcus melitensis *isolated from* Culex pipiens *and* Stegomyia fasciata.

Culex pipiens. *Monkey C.*

The monkey used in this experiment was brought from Calcutta and kept under observation for nearly two months before the experiment was commenced. Its blood was tested on many occasions, but no signs of a reaction with the *Micrococcus melitensis* were observed. On September 4 one of the colonies on the nutrose-agar plate, made with blood from the *Culex pipiens* caught in the Lazaretto, was planted on an agar slope, and on September 19 the growth resulting, emulsified in salt solution, was injected subcutaneously into Monkey C. A wave of fever followed, and on September 29 the blood reacted in a dilution of 1/10. On October 11 the blood serum, diluted 1/50, was found to cause immediate agglutination of the *Micrococcus melitensis.* On October 14 the monkey was killed. Cultures were made from the spleen, kidneys, liver, bile, mesenteric, femoral, and axillary glands, and hearts' blood. The micro-organism was recovered from the spleen and heart's blood; it was also found in considerable quantity in all the plates from the glands.

This monkey was also used for experiments on the conveyance of infection by mosquitoes.

Remarks.—The wave of fever, blood reaction, and recovery of *Micrococcus melitensis* from the organs show that the culture isolated from *Culex pipiens* was undoubtedly virulent.

Stegomyia fasciata. Monkey No. 101.

Monkey No. 101 had been under observation for several weeks, and its blood repeatedly tested, with negative results, before the experiment was commenced.

The *Micrococcus melitensis* was isolated from the mosquito on September 15 and sub-cultured on September 19. On September 24 an emulsion of the growth on an agar slope was injected subcutaneously into Monkey No. 101. A well-marked wave of fever resulted. On the sixth day after the injection the blood serum gave a complete reaction in a dilution of 1/10, and the temperature rose to 106°·8. On October 15 the temperature fell to the "normal level," but a few days later an irregular secondary wave of fever set in and the agglutination reaction increased. On October 22 the working dilution of serum was 1/50, and on the 29th 1/300. On November 12 the monkey was killed with chloroform. The blood serum, tested just before death, was found, when diluted 1/1000, to cause immediate agglutination of the *Micrococcus melitensis.*

The microbe was recovered in great profusion from the spleen and lymphatic glands, in less quantity from the liver, and very sparsely from the kidney. Each of six broth tubes, inoculated with 0·5 c.c. of blood from the heart, was found to contain the micrococcus.

This monkey was also used for experiments on the conveyance of infection by mosquitoes.

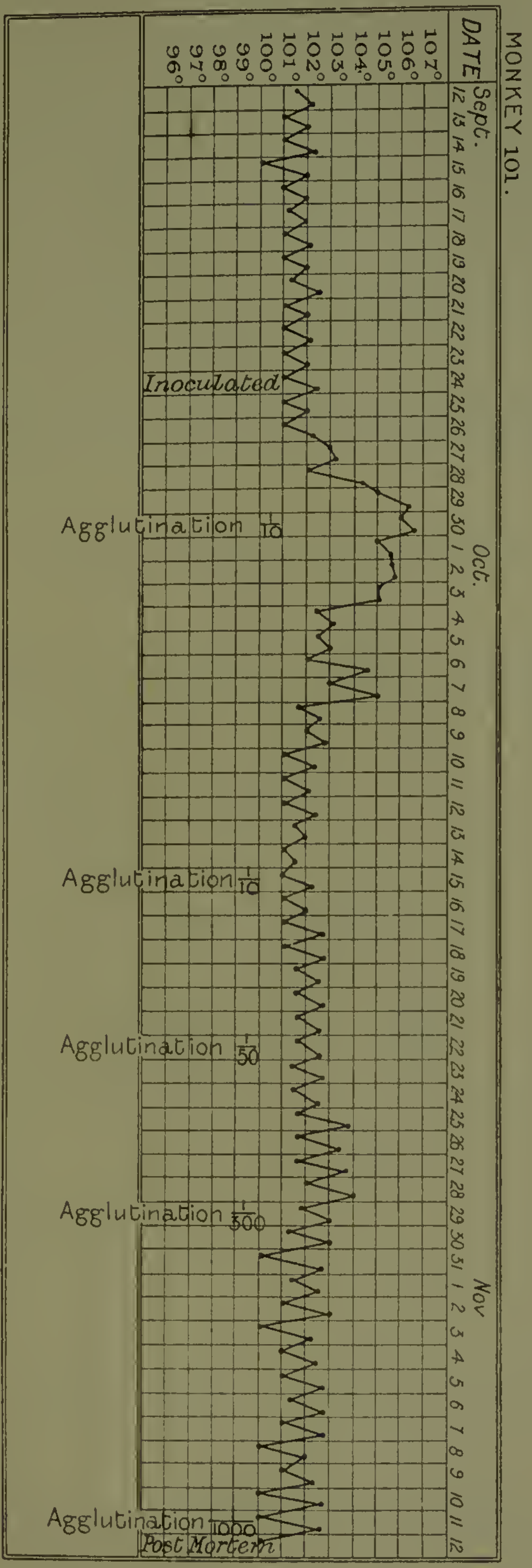
Remarks.—The marked wave of fever, strong blood reaction, and the presence of the *Micrococcus melitensis* in the blood and all the viscera show that the culture isolated from the *Stegomyia fasciata* was very virulent.

The chart (p. 77) shows the wave of fever during the experiment.

PART III.—TO DETERMINE WHETHER *Culex pipiens* AND *Stegomyia fasciata* CAN CONVEY THE INFECTION OF MEDITERRANEAN FEVER FROM MONKEY TO MAN, MAN TO MONKEY, AND MONKEY TO MONKEY.

Conveyance of Infection from Monkey to Man.

This experiment was not designed, but occurred in the following manner. On October 1 Monkey No. 6, infected by feeding, was being examined (by H.) in the verandah of the Lazaretto. Carlo Mifsud, the attendant in the Lazaretto, suddenly pointed to a mosquito, full of blood, resting on the table, and said, "that mosquito has just bitten me and I could not brush it away without letting go the Monkey." The mosquito was at once captured and dissected, with the results already detailed under the first recovery of the *Micrococcus melitensis* from *Culex pipiens.* On the day the mosquito was captured Carlo's blood was carefully examined, but no reaction with the *Micrococcus melitensis* was obtained. His temperature was also taken and found to be perfectly normal. The boy declared that he was perfectly well, and was much amused by the examination to which he was subjected. On October 11 he complained of feeling ill and returned to his home in Birchircara. On October 18 he was found to be suffering from fever and his blood serum caused immediate agglutination of the *Micrococcus melitensis.* The boy still has fever (November 20), temperature ranging between 102° and 103°, and is undoubtedly suffering from a typical attack of



Mediterranean Fever. He stated that he had constantly drunk raw goat's milk obtained from F—— of Balzan; but for some 12 weeks before his illness he was employed from 7 A.M. to about 8 P.M. in the Lazaretto, and whilst working there he obtained milk from healthy goats which were being kept under observation for future experiments. He also stated that there were no cases of fever in his house at Birchircara. The infection of the mosquito might easily have been acquired from the infected monkeys in the Lazaretto. At the time there were several monkeys which had been infected by feeding and by subcutaneous injection, and whose blood yielded the *Micrococcus melitensis* on culture. As soon as monkeys became infected it was the custom to bring them daily out of the dark mosquito-proof rooms into the verandah for better observation. It is not difficult to imagine that the mosquito which bit "Carlo Mifsud" had previously fed on these monkeys and so had taken the *Micrococcus melitensis* into its stomach.

Conveyance of Infection from Cases of Mediterranean Fever occurring in Man to Healthy Monkeys.

Experiment I.—*Conveyance of Infection by* Culex pipiens. On August 21 a batch of mosquitoes bred out from larvæ were fed on a patient in the Valletta Hospital. There were about 50 of them in the cage and many were found full of blood. On the evening of August 23 they were fed on Monkey No. 22. On the same day another batch of mosquitoes were fed on a patient in the Valletta Hospital; on August 24 and 25 this batch was fed on Monkey No. 22. The feedings were done in the evening, but it was noticed that very few of the mosquitoes attacked the monkey. It was therefore decided to place the healthy monkey in a mosquito-proof cage and let the mosquitoes loose inside the cage. Accordingly, on August 31 this was done and another batch of mosquitoes fed on a patient was also let loose at the same time. On September 4 another batch was set free in the cage. On September 19 still another batch of mosquitoes was let loose. A jar full of water was placed on a bracket inside the mosquito cage, and many larvæ were eventually found in the water. The blood of Monkey No. 22 was carefully examined once a week for a reaction until October 25, when a severe attack of dysentery set in. On November 17 the monkey, being *in extremis*, was killed with chloroform. At the *post-mortem* examination miliary tubercles were found in the organs, and the liver was "waxy." Cultures were made in the usual manner, but the *Micrococcus melitensis* was not isolated.

Remarks.—In this experiment over 250 mosquitoes were employed, but not more than half of them absorbed blood from the Mediterranean Fever patients. Careful examination of the mosquitoes in the cage occupied by the monkey was made from day to day, but none of them were noticed full of blood.

Experiment II.—This was conducted on the same lines as No. I, with the exception that the monkey was placed in a small mosquito-proof box instead of a large cage, the idea being to bring the mosquitoes in more intimate contact with the monkey. The box had a double bottom, the upper being made of narrow bars and the lower of solid wood. Flat dishes containing water were placed in the space below the narrow bars. At intervals of 48 hours mosquitoes were placed in the cage. About 300 mosquitoes, which had fed on patients, were used, but of these only 80 containing blood were counted. Monkey No. 18 was used in this experiment and its blood was tested weekly for a reaction with the *Micrococcus melitensis.* It became seriously ill in October and was chloroformed on November 17. At the *post-mortem* examination a condition of things very similar to Monkey No. 22 was found. Cultures were made in the usual manner, but no signs of *Micrococcus melitensis* appeared.

Conveyance of Infection by Culex pipiens *from Infected to Healthy Monkey.*

A small box covered with mosquito netting was divided into two compartments by wire-netting fastened below to a board let into a groove in the floor, a false bottom made of wire was put in each compartment. These precautions were taken in order to prevent the passage of urine from one side of the box to the other. Monkey C, suffering from a wave of fever, having been placed in one compartment and Monkey No. 3, quite healthy, in the other about 400 mosquitoes were let loose in the compartment occupied by Monkey C. Next day 200 more mosquitoes were introduced. Unfortunately Monkey No. 3 died suddenly four days after the experiment was commenced. Another healthy monkey was then placed in the box and every day for a week batches of about 200 mosquitoes were let loose in the cage. The healthy monkey never showed any signs of infection.

Conveyance of Infection by Stegomyia fasciata.

Experiment I (from man to monkey).—Monkey No. 16 was placed in a large mosquito-proof box, and 200 mosquitoes, which had fed on patients in the Cottonera Hospital, were placed in the cage. The mosquitoes remained alive for a week. The blood of the monkey was repeatedly examined, but no signs of a blood reaction were observed, though the monkey was kept under observation for two months.

Experiment II (from man to monkey).—A cage containing over 100 mosquitoes was placed on a patient in the Cottonera Hospital on October 2. On October 4, 5, and 6 the cage was placed on Monkey No. 17. On each occasion some of the mosquitoes were noted to feed freely. On October 6 a cage full of mosquitoes, fed 48 hours previously on a patient in the Valletta Hospital, was placed on the monkey. On

October 7, 8, 9, and 10 the cage was again applied to the monkey. The blood of Monkey No. 17 has been subjected to repeated examination, but no signs of a blood reaction have been observed up to the present time.

Experiment III (from monkey to monkey).—On September 30 a cage full of mosquitoes, bred from larvæ, was placed on Monkey No. 101, then at the top of a wave of fever. Next day the cage was again placed on Monkey No. 101, so as to ensure as far as possible that all the mosquitoes should have an opportunity of taking up blood. On October 3 and 4 the mosquitoes were fed on Monkey No. 14. On October 5 and 6 the mosquitoes were again placed on Monkey No. 101, but on both days many dead mosquitoes were found in the cage. On October 7 the mosquitoes still alive were fed on Monkey No. 14. On October 9 all the mosquitoes were found dead. Monkey No. 14 has been kept under observation up to the present time, but the serum has never reacted.

Remarks.—The results of the experiments were disappointing, but not unexpected. The dissections of mosquitoes obtained from the wards containing Mediterranean fever patents, showed that under the most favourable conditions not more than 1 per cent. would carry the *Micrococcus melitensis.* In the experiments on the conveyance of infection from man to monkey, endeavours were made to feed as many mosquitoes as possible, but it was practically impossible to feed more than 300 mosquitoes at one time on the patients in the wards, and of these probably not more than one-half would take up blood at the first feeding; so that even with this large number of mosquitoes there was only a probability that one would carry the infecting microbe.

In the conveyance of infection from monkey to monkey, the feelings and interests of the patients did not militate against the use of any desired number of mosquitoes, but the monkey experiments presented their own peculiar difficulties. The attempts to isolate the *Micrococcus melitensis* from the blood of infected monkeys clearly showed that the specific microbe was present in the blood to a small extent, and that it appeared at very uncertain periods after infection, as judged by the serum reaction, had taken place. The *Micrococcus melitensis* also did not seem to persist in the blood for any long period after its recovery. From the fifth to the tenth day after the appearance of the agglutination was found to be the best time for its recovery from the blood. Though often the attempts made during life to isolate the micrococcus proved failures, yet the specific microbe was occasionally found in the blood obtained at the *post-mortem* examination. Again, monkeys displayed an enormous difference in their powers of resistance to infection; for instance, Monkey No. 110, intended for mosquito experiments, could not be infected, though he received subcutaneously at various times the growth of *Micrococcus melitensis* on six agar slopes. Mosquitoes also did display the same predilection for monkeys as they did for man. It was often noticed that a cage full of *Culex pipiens* might be left for two hours in contact with a monkey, and not a single mosquito would bite. If, however, the same cage were transferred at once to the skin of man, the mosquitoes would commence to feed.

Conclusions drawn as to the Mode of Entrance of the Micrococcus melitensis *into the Human Body, based on the Work done up to End of November,* 1905. (W. H. H.)

(1) There is no evidence that Mediterranean Fever can be contracted by contact with cutaneous surfaces uncontaminated by urine.

(2) Infection can be acquired by the absorption of urine secreted by cases of Mediterranean Fever, and this is probably one way in which workers in hospital become infected.

(3) There is evidence to show that monkeys can be infected by dry dust artificially contaminated with cultures of *Micrococcus melitensis* isolated from the spleen of cases of Mediterranean Fever. The path of absorption may be through the nares, throat, respiratory passages, and alimentary canal. Dry dust contaminated with the urine of cases of Mediterranean Fever has given rise to infection in goats, but not in monkeys, up to the present time. The experience gained during the work performed in Malta during 1904–5 has convinced me that men are more susceptible to infection than monkeys and goats. Shaw's work on ambulatory cases of Mediterranean Fever amongst the Maltese has also shown that opportunities for the creation of infected dust are plentiful in Malta. Infected dry dust as a cause of Mediterranean Fever cannot therefore be discarded. When infection is acquired in this manner the incubation period is probably at least a month.

(4) Mediterranean Fever can be acquired by the absorption of infected goats' milk from the alimentary canal. The incubation period in this case is also probably long, and may even extend to two months.

This mode of infection probably plays a great part in the causation of Mediterranean Fever amongst the Maltese, who drink raw milk drawn at the doors of their houses.

(5) *Culex pipiens* and *Stegomyia fasciata* act as carriers of the *Micrococcus melitensis*, and the case of Carlo Mifsud renders it extremely probable that human beings are infected by the bites of infected mosquitoes.

(6) I believe that infected goats and infected mosquitoes play a greater part in the causation of Mediterranean Fever than the absorption of infected dust.

Preventive Measures.

If the conclusions drawn as to the mode of entrance of the *Micrococcus melitensis* into the human body be accepted, preventive measures should obviously be based on the following lines:—

(1) *Destruction of Infected Goats in Malta.*—The best indication of infection appears to be the milk agglutination test suggested by Zammit; unfortunately the test requires to be performed by a worker of considerable experience, and, judging by my own work, I think the hanging drop is preferable to the capillary tube employed by Zammit. The serum test is easier to perform, and as the experimental work has shown that goats may have a marked blood reaction, and that the *Micrococcus melitensis* may be present in the blood without the specific microbe necessarily appearing in the milk, all goats showing a decided serum reaction (dilution 1/20) should be destroyed. Examination of the milk alone cannot be taken as a basis of action in relation to goats, as we know that the excretion of the *Micrococcus melitensis* in the milk may be intermittent, and goats may be infected for some two to three months before the *Micrococcus melitensis* appears in the milk.

As goats may become infected by eating rubbish polluted with urine in the streets of Malta, and they themselves, when infected, excrete the *Micrococcus melitensis* in the urine, so, adding to the contamination of the public thoroughfares, it is plain that the perambulation of goats through the streets of Malta should be forbidden. The goats should either be milked in their pens, and the milk transmitted to the chief towns in sealed cans, or the goats should be assembled in some central depôt outside the towns, and the yard of the depôt should have a cemented surface, which can be thoroughly cleansed after the milking operations are over. As there is a strong probability that infection is also carried from infected human beings to goats by mosquitoes, the keeping of goats in houses, and in small yards attached to houses, should be forbidden. Goats should be kept in pens as far away from human habitations as circumstances will allow.

(2) *Destruction of the Larvæ of Mosquitoes.*—This is a large order in a place like Malta; but it must be attempted if the disease is to be stamped out. By means of pamphlets, householders should be instructed to apply oil to the surface of all stagnant water on their premises. About 15 c.c. of oil are sufficient for a square metre of surface; the application should be repeated every 15 days in the hot weather. The oiling of stagnant water in the houses of the poor should be performed by the sanitary authority.

(3) Promiscuous micturition about the streets should be forbidden, and a heavy penalty inflicted on any offender. By means of leaflets, the people should be educated to understand the importance of preserving some degree of sanitation in their dwellings, especially in relation to cleansing and flushing W.C.'s. Second class water for flushing purposes should not be made a means of revenue, but should be supplied at cost price.

VIII.—EXPERIMENTS ON MOSQUITOES AND FLIES.

By Captain J. CRAWFORD KENNEDY, R.A.M.C.

(Received December 16, 1905.)

I.—EXPERIMENTS WITH THE OBJECT OF INFECTING MOSQUITOES ARTIFICIALLY AND OF ATTEMPTING THEREAFTER TO INFECT A MONKEY.

Mosquitoes which had fed on uninfected people were collected full of blood and kept alive for several days by feeding them on a thick emulsion of *Micrococcus melitensis*, thereafter they were fed at regular intervals on Monkey No. 19. This animal had formerly been used for the *Stomoxys* experiment (see p. 66), but the last exposure to infection was on September 17, 25 days before this experiment was started, and no reaction had been detected in its blood.

Between the period from October 12 to November 3 about 40 mosquitoes, which had been treated as just mentioned, fed on this monkey. On October 5 the animal was very ill with dysentery, but no trace of reaction was found in its blood. On the 8th it died, and though a careful *post-mortem* examination was made of all its organs, no *Micrococcus melitensis* was recovered.

Dissections of the infected mosquitoes were made occasionally, and *Micrococcus melitensis* was recovered from the stomach once and from the thorax once; unfortunately in the latter instance the œsophagus had not been excluded from the muscular tissue.

II.—OBSERVATIONS ON *Stomoxys calcitrans*.

During the summer, when visiting the various herds of goats for the examination of blood and milk, I found that the sheds where the goats were housed were infested with a fly that resembled the common house fly, but had a piercing proboscis. I took this to be a *Stomoxys*, and this observation was kindly confirmed by Mr. Austen, of the British Museum, to whom I sent specimens, and who informed me that it was the *Stomoxys calcitrans*, but slightly smaller than the British variety. This fly is to be found all over Malta, and even in houses in town. It attacks viciously both animals and human beings, and its bite is very irritating; it sucks the blood of its victims, and is capable of holding a considerable quantity. Thinking that this fly might have some share in conveying the disease from goat to goat, I had supplies collected from a goat shed where a large number of the goats were infected, and carried out the following experiments.

Experiment 1.—Monkey No. 129, uninfected; blood gives no reaction. From August 15 to 20, flies straight from the goat shed were fed on this monkey; 25 flies bit well. From August 21 to 24 the same flies were fed on Monkey No. 107 (an infected monkey) before being again fed on Monkey No. 129. Monkey No. 129 was bitten by seven of these.

On August 25, Monkey No. 129 unfortunately died from peritonitis. No trace of *Micrococcus melitensis* was found in any of its organs, nor did its blood react.

Experiment 2.—Monkey No. 19, uninfected. Blood does not react. On August 25, 20 freshly caught flies were fed on this monkey. During the period between August 28 and September 15, 60 flies, which had been regularly fed on infected monkeys, were at intervals fed on this monkey. The animal has never shown any sign of reacting to *Micrococcus melitensis.*

Experiment 3.—Monkey No. 21, uninfected. Blood does not react. During the period between August 30 and September 7, 50 flies, which had been fed on infected monkeys, were thereafter fed on this monkey. The animal never showed signs of an agglutinative reaction, and died on September 22 (15 days after the last feeding) from peritonitis and tubercle of the lung. No *Micrococcus melitensis* was recovered from any of its organs at the *post-mortem* examination.

As the cooler weather approached it became increasingly difficult to obtain these flies in sufficient quantities for experimental work, and therefore further work is postponed.

Dissections.—Several of the flies were dissected out, and the various organs planted out on Petrie dishes, but no *Micrococcus melitensis* was recovered from any of these.

IX.—EXAMINATION OF ANIMALS IN CONNECTION WITH MEDITERRANEAN FEVER.

By Captain J. CRAWFORD KENNEDY, R.A.M.C.

(Received December 16, 1905.)

I.—THE EXAMINATION OF DOGS.

A series of 114 stray dogs, which had been seized by the police on the streets or in the suburbs of Valletta, Floriana, and Sliema, were examined. The animals were kept for 24 hours, in case they should be claimed by possible owners, and were then destroyed. Preparatory to their destruction, I examined their blood for an agglutinative reaction to the *Micrococcus melitensis*, and if a positive reaction were obtained, I made a *post-mortem* examination.

The agglutinative reaction was tried in dilutions of 1/10 and 1/30, with a time limit of half an hour. No sample was found to agglutinate beyond 1/30, unless it had stood for two hours.

The result was a positive reaction in 15 cases out of the total of 114, being a percentage of 13·15.

The following table gives at a glance the degree of reaction obtained. Each dog is described by a number which is placed in the column corresponding to the degree of the serum reaction.

	Reaction incomplete, 1/10.	Reaction complete, 1/10.	Reaction complete, 1/30.
Dogs by numbers	16 23 47 (no *post-mortem*) 76 83 111	3 11 73 90 101 103	35 44 107
Total......	6	6	3 = 15

The degree of reaction is in no instance high, and but for the result of the *post-mortem* examination might very well be ignored.

Of the 15 dogs noted in the table, 14 were examined *post-mortem*. The routine adopted was to make cultivations on Petrie dishes from the following organs :—the spleen, the liver, the mesenteric, femoral, and axillary glands, and the urine ; broth cultures were also made from the heart's blood.

The result was that the *Micrococcus melitensis* was recovered in only one instance; this was from No. 44, whose blood reacted up to 1/30 dilution, but did not go further. No. 44 was a dark brown short-haired bitch of Maltese breed, well advanced in pregnancy. Cultures on plates were made from the spleen, the liver, the mesenteric and femoral glands, and the urine. *Micrococcus melitensis* was recovered only from two plates made from the mesenteric glands. All the other organs were sterile and contained no micrococcus. The spleen was most carefully examined, practically the whole of the organ was cut into thin slices and smeared on six large Petrie dishes. The two plates made from the mesenteric glands contained respectively one and 34 colonies of *Micrococcus melitensis.*[*]

Summary.—None of the 114 dogs had the disease in an acute form.

One dog contained *Micrococcus melitensis* in its mesenteric glands.

At least nine (omitting the six with an incomplete reaction) showed unmistakable signs of infection—a percentage of 8.

Conclusions.—Sufficient proof is here presented that dogs become infected by the microbe of Mediterranean Fever. Although I have not happened to come across one with the disease in an acute form, and have not been able so far to demonstrate the presence of the *Micrococcus melitensis* in the excretions, still there is no reason to suppose that infected dogs do not excrete the microbe in their urine as do other infected animals. The importance of this source as another cause of infection will be readily recognised, and in this connection it is interesting to note that 3410 stray dogs were seized and destroyed by the police during last year in Malta alone.[†]

I am informed by Mr. Curmi, the Superintendent of Police, that the total number of dogs in Malta and Gozo is at least 40,000.

II.—PRELIMINARY NOTE ON MULES AND MALTESE STABLE EMPLOYÉS.

With the kind permission of Colonel Winter, Director of Supplies and Transport, I was enabled to examine the blood of 87 mules belonging to Government and used for transport purposes. The animals are not Maltese bred and have been in Malta for periods varying from 6 months to 10 years. They are groomed and driven by Maltese carters, and all the stable-hands are Maltese.

Those which I examined were quartered in three different stables:—

St. James's Ditch, Valletta.
San Marco, Valletta.
St. Paul's, Cottonera.

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[*] Though it may be merely a coincidence that *Micrococcus melitensis* was recovered only from the mesenteric glands, it suggests that the infection had entered by way of the alimentary tract.

[†] Police Report, Malta, 1904–05.

St. James's Ditch Stables are the more modern and more sanitary buildings, well ventilated and airy, and are situated just outside the walls of Valletta.

San Marco Stables, standing in a low and thickly-populated part of the town, are poorly ventilated, shut in on all sides, and damp.

St. Paul's Stables are situated in the high ramparts of St. John's Bastion, in Cottonera lines. They overlook a slope thick with prickly pear, there is also a deep well just outside. The place is said to be infested with mosquitoes in the summer time.

I am informed that with the exception of some influenza and simple fever very little sickness occurs amongst the mules. In appearance the animals are sleek and in good condition.

On my first visit to the stables one of the mules which I examined (No. 42,290) gave a negative serum-reaction. On my second visit 12 days afterwards I was informed that this animal was on the sick list with slight fever, and had been off duty for a few days, but was returning to work next day. I therefore examined its blood again, and obtained a complete agglutination of *Micrococcus melitensis* in a dilution of 1/10, it did not, however, agglutinate in 1/20. This mule was undoubtedly suffering from a slight attack of Mediterranean Fever.

I have now (2 months later) examined its blood again, and find that it reacts completely in 1/10 and incompletely in 1/20 in half an hour. In the absence of any other means of proving the presence of the disease among these mules this was a very opportune case.

The following table gives the number of mules examined according to their service in Malta, and the stables in which they were quartered:—

Table A.

Service in Malta.	Quartered in stables at—			Total number examined.
	St. James's Ditch.	San Marco.	Cottonera.	
Under 1 year ...	6	—	—	6
1— 2 years......	9	28	—	37
2— 3 ,, ...	2	—	1	3
3— 4 ,, ...	1	—	1	2
4— 5 ,, ...	1	—	1	2
5— 6 ,, ...	3	—	4	7
6— 7 ,, ...	9	1	6	16
7— 8 ,, ...	3	—	4	7
8— 9 ,, ...	1	—	3	4
9—10 ,, ...	2	—	1	3
Total	37	29	21	87

Each sample of blood was examined in dilutions of 1/10 to 1/50, with a time limit of half an hour. A reaction was obtained in 39 cases, or 44·8 per cent., and the following table (B) gives these worked out to their highest dilutions:—

Table B.

Dilutions ...	1/10.	1/20.		1/30.		1/40.	Total.
		In-complete.	Complete.	In-complete.	Complete.	In-complete.	
Number of mules which reacted	23	6	6	2	—	2	39

I was enabled, through the courtesy of Mr. Macfarlane, M.R.C.V.S., to make *post-mortem* examinations of three mules which had to be destroyed on account of age and unfitness. I had previously examined samples of their blood, and found that one (No. 43,013) reacted in dilution 1/20, another incompletely in 1/10, and the third not at all. Cultures were made from the spleen, the mesenteric and femoral glands, and also, in the case of No. 43,013, from the liver. In every case these organs contained no *Micrococcus melitensis*.

To assist in arriving at some conclusions from these observations I drew up the facts in tabular form as follows:—

Table C.—Number of Infected Mules by Service in Malta.

	Under 1 yr.	1–2 yrs.	2–3 yrs.	3–4 yrs.	4–5 yrs.	5–6 yrs.	6–7 yrs.	7–8 yrs.	8–9 yrs.	9–10 yrs.	Total.
Number of mules examined	6	37	3	2	2	7	16	7	4	3	87
Number which reacted	1	21	2	1	1	4	5	3	1	0	39

Table D.—Number of Infected Mules according to Stables.

	St. James's Ditch.	San Marco.	Cottonera.	Total.
Number of mules examined	37	29	21	87
Number which reacted	10	15	14	39
Percentage...	27	51·7	66·6	

Table E.—Number of Infected Mules of less than Two Years' Service, according to their Stables.

Mules under 2 years' service.	St. James's Ditch.	San Marco.	Cottonera.	Total.
Number examined	15	28	—	43
Number which reacted	7	15	—	22
Percentage...	46·6	53·5	—	51·1

A study of these tables suggests the following observations:—

(1) Mules of less than two years' service show a slightly larger proportion of infected cases than those of more than two years' service. This difference becomes much more marked as the reactions in the lower dilutions are eliminated, as shown in the next table (F). For the purposes of this comparison it is convenient that half the total number examined were under, and the other half over, two years' service.

Table F.

Number of mules.	Service in Malta.		Total.
	Under 2 years.	Over 2 years.	
Examined	43	44	87
Reacted in 1/10	22	17	39
,, 1/20	7	3	10
,, 1/30	4	—	4

It will be seen that none of more than two years' service reached the 1/30 dilution, while only three out of a total of 10 reached 1/20. This points to a more severe or more recent infection among the later arrivals in the island.

(2) The stables at San Marco and at Cottonera show a larger proportion of infected animals than those in the Ditch. This, in the case of San Marco, is, I think, more apparent than real, for this reason, that most of the mules of less than two years' service are quartered there. When the two stables (San Marco and the Ditch) are compared by mules of the same length of service, the difference almost disappears. At the Ditch there were 7 infected out of 15 examined = 46·6 per cent. At San Marco 15 out of 28 = 53·5 per cent.

At Cottonera all the mules are of more than two years' service, and comparing them with those of the same service at the Ditch, we find that the larger proportion of infected cases at Cottonera is undoubted. At the Ditch there were 3 infected out of 22 examined = 13·6 per cent.; and at Cottonera 14 out of 21 = 66·6 per cent. There are therefore in proportion four times more infected mules in Cottonera than in the Ditch or in San Marco.

Summary.—Blood serum reaction to *Micrococcus melitensis* was obtained in 44·8 per cent. mules examined. In one case the appearance of the serum reaction was coincident with a slight attack of fever The serum reaction obtained was in every case rather low, only two reaching 1/40.* The highest reactions were obtained in those of under two years' service in Malta. In proportion there were four times more infected mules in Cottonera than in the Valletta stables.

Conclusions.—Mules are exposed to and suffer in a mild way from infection by *Micrococcus melitensis.* I reserve other remarks until further investigation has been carried out.

The Maltese Stable Employés.

The examination of those employed in the stables was a natural sequel to the examination of the mules. They are all Maltese, who have been employed with the Army Service Corps for periods varying between 20 years and 20 months: a good many new hands were taken on 20 months ago, and of these I examined 33. The total number examined was 80. I have divided them into two classes according to their employment.

(1) *Carters.*—These men drive the mules and spend most of their day on the road. They also groom their mules and spend one night in 8 or 9 on stable guard, when they remain on duty in the stables all night. On other nights they sleep at their respective homes.

(2) *Stable-keepers or Labourers.*—These men are the sweepers and general labourers in the stables; they spend practically the whole day in and about the stables, and on one night in every three they sleep there.

The result of the examination of the blood of these men for a reaction to *Micrococcus melitensis* was as follows:—

1. *Carters.*—The total number examined was 73, and of these 30 had been only 20 months in the service. Four gave a reaction; two in 1/30 and two in 1/10 dilutions. Their particulars are as follows—

    No. 80.—Reacted 1/30; 13 years employed; says that he had fever lasting 2 months 3 years ago, and that he is in good health now. Temperature when examined 99°·6.

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* To compare low serum reaction in animals, *vide* Report on Malta Fever in Dogs, *ante* p. 84.

No. 121.—Reacts 1/30; 20 months employed; was sick with fever and pains in head 4 months ago.

No. 112.—Reacted 1/10; 20 months employed; had fever lasting 18 days 4 years ago; is in good health now.

No. 114.—Reacted 1/10; 14 months employed at Cottonera; says that he has never been sick except for pains in the head during the summer. Temperature normal.

Besides these cases, faint reactions were obtained in 3 others who had a history of fever many years ago, they were all old hands.

Nos. 80 and 121 are the only ones out of the above 4 that can definitely be said to have contracted fever whilst employed in the A.S.C. stables; and No. 121 is the only one out of 30 with 20 months' service who has taken the disease.

2. *Stable-keepers.*—The total number examined was 7, and of these 3 had 20 months' service. Two reacted. Their particulars are—

S. A——.—Reacted in 1/30; 20 months employed; fell sick at San Marco Stables in the beginning of the summer and was ill for 4 months.

S. V——.—Reacted in 1/10; 6 years employed; had fever some years ago.

Both these stablemen contracted the disease whilst employed in the stables, and S. A—— is one of three who have only 20 months' service.

Summary.—Of a total of 80 men examined, 4 (= 5 per cent.) showed signs of a more or less recent infection and had contracted the disease whilst employed in the stables. Two were stablemen and 2 were carters, being 28 per cent. of stablemen as compared with 2·5 per cent. of carters. Two out of 33, or 6 per cent., contracted the disease within 20 months of starting work at the stables, one of them was a stable-keeper, being 1 in 3 stablemen as compared with 1 in 30 carters.

Conclusions.—These observations are suggestive of lines of future work, especially with regard to biting insects.

X.—BACTERIOLOGICAL EXAMINATIONS OF CASES OF MEDITERRANEAN FEVER.

By Captain J. CRAWFORD KENNEDY, R.A.M.C.

(Received December 16, 1905.)

I.—EXAMINATION OF SALIVA.

The cases examined were four in number, and were selected on account of their severity.

CASE A.—A very severe case with persistent and irregular fever, no normal temperature for 90 days; extreme anæmia. Samples of saliva were taken from this case on the following days of disease, 36th, 37th, 38th, 39th, 41st, 42nd, 68th, 69th, 70th, 71st, 72nd, 73rd, 74th, 75th, 76th, 77th, 83rd and 84th.

CASE B.—A moderately severe case with four well-marked "waves" of fever. The third wave was the most severe. Samples of saliva were collected on the following days of the disease, during the comparative apyrexial period between the 3rd and 4th "waves," the 58th, 59th, 60th, 61st, 63rd and 64th days.

CASE C.—A severe case with marked anæmia. First "wave" severe, prolonged, lasting 30 days. Second "wave" very acute, lasting 21 days. Samples of saliva collected in the period between the 1st and 2nd "waves" on the following days of disease, the 42nd, 43rd, 44th, 45th, 47th and 48th.

CASE D.—First "wave" ran a regular course, with little constitutional disturbance, though temperature was high; it lasted 34 days. The samples of saliva were collected on the 38th and 39th days of disease during the apyrexial period before the second "wave."

Method of Collecting the Saliva.—It was attempted to collect the saliva as it escaped from the orifices of the ducts, but, on account of the inconvenience caused to the patients, this was not peristed in. The patient was therefore asked to spit into a sterile test-tube after his mouth had been well cleansed by means of a tooth brush and carbolic powder and well rinsed with a solution of boracic acid.

Method of Examination.—The saliva, being loaded with contaminating organisms, and, in especial, with acid producing *Streptococci*, requires to be greatly diluted before its culture on plates could be attempted with any chance of success. Two or three methods were tried, but the following was finally adopted:—

Four or five test-tubes, each containing 10 c.c. of distilled water, were sterilised and labelled respectively A, B, C, D, E. To A was added 1 c.c. of the saliva; to B 1 c.c. of the mixture in A; to C 1 c.c. of the mixture in B, and so on. The diluted saliva was then planted out on Petrie dishes containing the nutrose litmus agar, 1 c.c. from each tube being distributed over four plates.

After incubation for four days the plates made from tubes A and B were, as a rule, found to be crowded with acid colonies, and quite useless. The higher dilutions gave very clean plates; 298 plates were thus examined, but *Micrococcus melitensis* was not recovered.

Result.—In 32 samples of saliva from Mediterranean Fever patients in varying stages of the disease, no *Micrococcus melitensis* was found.

II.—*Post-mortem* EXAMINATION OF FATAL CASES OF MEDITERRANEAN FEVER.

During the year 1905 a more or less systematic *post-mortem* examination of fatal cases has been carried out in order to obtain some idea of the distribution of the *Micrococcus melitensis* in the human body. A series of nine cases has been collected and to these I have added four others which occurred in the previous year. A number of these have been examined in conjunction with Major Horrocks. My observations and remarks are recorded concisely under the headings of the various organs, and the accompanying table will show at a glance the proportion of recoveries of *Micrococcus melitensis* from each organ.

Spleen and Liver.—These organs invariably contain *Micrococcus melitensis* in large quantities during the febrile stage.

Kidney.—The organism is not so abundant here and in one case was not obtained.

Bile.—Eight samples were cultured, and from two *Micrococcus melitensis* was recovered in pure culture, but in no great quantity.

Bile Duct and Bladder.—Scrapings were made from the walls in two instances. No recovery of the microbe was made.

Urine.—Last year, when the urine investigation was being carried on, three samples were taken from the bladder: one sample contained the microbe. This was the second occasion on which *Micrococcus melitensis* was found in the urine.

Intestines.—These were examined in four cases, and several hundred plates were made from scrapings from the walls or from the contents of the duodenum jejunum, ileum, and colon. The specific microbe was not detected, although it must be present, seeing that it occurs in the bile, but it evidently does not multiply in the intestines.

Bone marrow was examined in four cases. Recoveries of the microbe were made in two of these. In one of them the colonies of *Micrococcus* were very profuse.

Heart's Blood.—Cultures were made in four instances, two of which yielded the microbe. One of the unsuccessful cases was a chronic one of a month and a half's duration; in the other only a very small quantity of blood was used.

Pericardial Fluid.—In one case out of two *Micrococcus melitensis* was recovered; this was one which had lasted for a month and a half.

Pleural Fluid.—One case was examined; result, negative.

Cerebro-Spinal Fluid.—This was examined in two cases with marked meningeal symptoms. The fluid was much increased in quantity and had caused a good deal of flattening of the cerebral convolutions. Great difficulty was experienced in keeping it free from contaminations. No *Micrococcus melitensis* was recovered.

Lymphatic Glands.—A distinct advance has been made by the discovery that the lympathic glands are great receptacles for the *Micrococcus.* In one of my later cases I was struck by the size and appearance of the mesenteric glands. They were similar to what are found in enteric fever—the size of a large marble, fluid in the centre and the capsule injected. On being cut, they were found to contain what was to all appearance pus. A loopful of this fluid was spread over several Petrie dishes containing the usual nutrient medium, and after incubating for four days a pure growth of *Micrococcus melitensis* resulted, so profuse as to cover every part of the plate that had been touched by the platinum wire. After this discovery the glands from other parts of the body were examined and also found to contain microbes in great quantity. In one case the glands from the axilla groin, mesentery, carotid and mediastinum were examined, but only from the mediastinal was the microbe obtained. In another case where the femoral, thoracic and mesenteric glands were examined, the microbe was present in the femoral and thoracic, but not in the mesenteric.

This observation has been of the greatest value in the *post-mortem* examinations of experimental animals. In many cases they take the disease in a mild form, and the specific microbe soon dies out of the spleen, remaining, however, for a longer time in the glands. Therefore the routine practice at *post-mortem* examinations is to examine the femoral, axillary and mesenteric glands, as well as the other organs. Had this not been done many *post-mortem* examinations must have proved negative, seeing that the glands were the only organs which contained *Micrococcus melitensis.*

The following idea is suggested by the foregoing observations. If the mode of infection happen to be through a mucous membrane, *i.e.*, the alimentary canal, the glands draining that area offer a good nidus for the multiplication of the *Micrococcus melitensis*, and in time form a good focus from which the whole system becomes infected. I think that many cases with long incubation periods might be explained in this way: For instance, a common type of the disease is manifested as follows:—

First, a slight attack of fever, labelled, for want of a better term, S.C. Fever, lasting two, three, or four days, with no agglutinative reaction in the blood. This probably coincides with the local invasion.

Second, a period of quiescence lasting three weeks to a month or longer, the period of incubation.

Third, sharp attack of high fever, with no appreciable enlargement of the spleen till the third or fourth day. This marks the systemic invasion and the full development of the disease.

Tonsils.—In view of the glandular character of these organs and a possible entrance for infection, four cases were examined, but no *Micrococcus melitensis* was isolated.

Salivary Glands.—Concurrently with the examination of the saliva, two cases were examined *post-mortem*, but without the recovery of the microbe.

Table and Summary.

Organ.	Number of times examined.	Number of times *Micrococcus melitensis* recovered.
Spleen	13	13 = 100 p. c.
Liver	3	3 = 100 ,,
Kidney	7	6 = 85 ,,
Urine	3	1
Lymphatic glands	5	5 = 100 ,,
Mediastinal	1	1
Thoracic	1	1
Mesenteric	5	3
Femoral	3	2
Axillary	1	0
Carotid	1	0
Heart's blood	4	2
Pericardial fluid	2	1
Bone marrow	4	2
Bile	8	2
Bile duct and bladder	2	0
Intestines	4	0
Duodenum	4	0
Jejunum	3	0
Ileum	3	0
Colon	1	0
Salivary glands	2	0
Tonsils	4	0
Pleural fluid	1	0
Cerebro-spinal fluid	2	0

XI.—AN EXAMINATION OF GOATS IN MALTA, WITH A VIEW TO ASCERTAIN TO WHAT EXTENT THEY ARE INFECTED WITH MEDITERRANEAN FEVER.

By Dr. T. Zammit.

(Received December 18, 1905.)

I.—Attempts to Recover *Micrococcus melitensis* from Goats Slaughtered at the Civil Abattoir.

As soon as goats were suspected to be liable to the infection of Mediterranean Fever, an examination of the animals slaughtered at the civil abattoir was undertaken. None of the animals had been previously selected or examined, and some of them turned out to be male Barbary goats which had been brought to Malta to be fattened and sold as mutton. When a goat was killed a capillary tube was filled with blood for the serum test, and the spleen was carefully removed and taken to the laboratory for examination; 46 goats were thus examined, and the microbe was recovered in one case only. The serum reaction showed, however, that more than one goat had at some time been suffering from Mediterranean Fever, for seven of the bloods gave a clear positive reaction with *Micrococcus melitensis* at a dilution of at least 1 in 80. All the goats appeared to be in good condition, and were passed for consumption by the veterinary surgeon of the abattoir.

II.—*Post-mortem* Examination of Goats bought in June, 1904.

The goats bought by us in June, 1904, and found to be suffering from Mediterranean Fever, were slaughtered in September, 1905. Of six animals, numbered one to six, No. 4 never gave a reaction for Mediterranean Fever, and was therefore used for other experiments. No. 3 always reacted strongly after it was sent to the Lazaretto. In July, 1905, it lost flesh, and on August 2, being in a dying condition, it was killed and carefully examined. A large number of broth and agar tubes were inoculated with material taken from all the organs, but the *Micrococcus melitensis* was not recovered. Nos. 1, 2, 5, 6 appeared quite healthy. They were slaughtered between September 25 and 29. The animals were in perfect condition, very fat, and with all the organs apparently healthy.

A great number of culture tubes were used for the examination, and, fortunately so, for if fewer had been used it is probable that the microbe would have escaped notice in some of the cases. The *Micrococcus melitensis* was recovered from all the goats except from No. 2. During life this micro-organism had only been obtained from the blood of Nos. 5 and 6, but on the other hand it had been recovered from the urine and milk of all four goats. At the *post-mortem* examination the microbe appeared to be irregularly distributed in the body and in rather small numbers.

In No. 1 it was obtained from the spleen and the kidneys, but in small quantities. In No. 5 it was recovered from the kidneys only. In No. 6 it was only found in the glands.

Other goats (Nos. 15, 16, 17, 18), affected with Mediterranean Fever, were slaughtered in September. The *Micrococcus melitensis* was recovered from all except from No. 18. In No. 15 it was obtained abundantly from the kidneys. In Nos. 16 and 17 only a few colonies were procured from the lymphatic glands.

The serum reaction remained positive and constant in all the bloods, though in some of them it became very weak, not higher than 1 in 40.

The *Micrococcus melitensis* in infected goats tends to disappear from the system after a time, but the process is slow.

Our goats having been bought in June, 1904, already infected, we could not ascertain how long they might have been in that condition, but it is a fact that after 15 months the specific micro-organism was still living in their lymphatic glands.

III. Recovery of *Micrococcus melitensis* from the Blood of Goats.

In certain phases of the disease the specific microbe circulates freely in the blood, and it can then be easily recovered. This condition does not seem, however, to last long, since a blood which yields the microbe one day, will not show any after the lapse of a week. About 5 c.c. of blood were taken from the jugular vein of goats 32 times. The same animal was sometimes tried three or four times. The blood was distributed in 20 c.c. broth tubes and incubated. The *Micrococcus* was only recovered from four goats (Nos. 5, 6, 21, and 29). The animals had all contracted the disease before they were obtained, and as when brought to us they already displayed a strong serum reaction, no idea could be formed as to the stage of the disease at which they had then arrived. Some of the cases were undoubtedly of long standing.

IV. The Reaction of Goat's Milk to the *Micrococcus melitensis.*

On July 10, 1905, I observed that the agglutination test could be applied to the milk of goats affected by Mediterranean Fever as well as to the blood. At a point in our investigations it had become difficult to obtain samples of blood from goats, as the owners strongly objected to have their animals bled. The use of milk instead of blood for the specific reaction proved a great help and enabled us to examine a large number of goats.

The test can be applied on a slide in the ordinary way or in capillary pipettes as in the method of precipitation. In time, however, the precipitation method was adopted as being more conclusive and easier to work, especially when a great number of samples had to be dealt with.

The only precaution to be taken in applying the test is the addition of an antiseptic, strong enough to prevent the clotting of the milk, but without affecting in any way the agglutinins. For the examination of a large number of samples the following method was found to answer best:—

A strong emulsion of the *Micrococcus melitensis* is prepared in normal saline solution in a watch-glass. To this a small quantity of formaldehyde solution is added (one small loopful of a 1-per-cent. solution), the whole being drawn into a pipette. One drop of the emulsion is placed on a glass slide and a loopful of milk is mixed thoroughly into it. This mixture is then drawn up into a fine capillary pipette, left in an upright position for 12 hours, and the reaction noted at the end of that time. The reaction is often seen after a few minutes. The cream collects at the surface and does not interfere with the reaction.

Between July 10 and September 22, 1905, 710 samples of milk were examined and a positive reaction was obtained 133 times.

With a view to check the value of this method all the milks that showed a positive reaction were tested a second time. Further, where possible, blood was obtained from the animal for the serum test, and the suspected milk was plated out.

The blood test constantly confirmed the milk test, and when a strong reaction was obtained the specific microbe was always recovered from the milk. In conclusion, in my opinion, the milk test is a safe one and quite as reliable as the blood test. For sanitary purposes, more especially where a great number of goats have to be examined, the milk test is at once convenient and efficient.

V. THE MILK TEST AS APPLIED TO GOATS IN THE COUNTRY.

As soon as the susceptibility of the goat to Mediterranean Fever had been established it became obviously desirable to ascertain how far herds which supplied milk to the towns and villages were affected. In July, 1905, we heard from one of the district medical officers that cases of the fever were numerous in two villages, Lia and Balzan, whereas few or none were reported from the neighbouring village of Attard. These three villages form a group lying close together about the centre of the island.

It was decided, therefore, to examine the herds of this group of villages first and then work in other directions according to circumstances. Every village has a number of herds, but many goats are distributed singly, every family, as a rule, keeping a goat for its own use. I have arranged the result of the examination in the following tabular form :—

Name of village.	Street.	Number of goats in herd.	Number of goats which reacted.	Remarks.
Lia	Molino Musta	15	None	
,,	Forni, 12	7	2	
,,	,, 24	4	None	
,,	Concezione	9	,,	
,,	Molino, 28	5	,,	
,,	Preziosi	13	,,	
,,	Concezione	11	,,	
,,	Reale, 9	1	,,	
,,	,, 128	2	,,	
,,	Stretta Enea, 2	1	,,	
,,	,, 3	6	,,	
,,	Concezione, 33	1	,,	
,,	,, Vlo, 3°	2	1	*Micrococcus melitensis* recovered. Case of Mediterranean Fever on the premises. Goats were being taken to Mosta.
,,	,, 28	4	None	
,,	Forni, 54	1	,,	
,,	,, 42	1	,,	
,,	S. Andrea, 15	1	,,	
,,	No address	4	2	
,,	Reale, 82	12	7	
Balzan	Reale, Vlo, 2°	18	6	The *Micrococcus* recovered from 3. 2 cases of Mediterranean Fever on the premises during the last twelvemonth.
,,	Provvidenza Vlo, 2°	20	2	
,,	,, Vlo, 3°	7	None	
,,	,, Vlo, 2°	17	3	
,,	,,	16	2	
,,	3 Chiese, 25	18	2	
,,	,, 9	1	None	
,,	,, 33	1	1	
,,	Itmeida, 16	1	1	Case of Mediterranean Fever on the premises.
,,	No address	3	2*	
Attard	Via C. Cormi, 22	5	None	
,,	,, 2	2	,,	*Goats were being taken to Mosta.
,,	Via Notabile, 3	7	,,	
,,	Reale, 24	2	,,	
,,	Lunatic Asylum	31	,,	
,,	Molino Vlo, 1°	4	,,	
,,	,, 14	5	,,	
,,	S. Domenico, 19	6	,,	
Zeitun	Herba, 16	8	,,	
,,	Giardino Botanico, 10	10	,,	
,,	Vlo Privato, 3	6	,,	
,,	Piazza Maggiore, 44	12	,,	
,,	Madonna Pietà, 119	11	1	
,,	Giardino B.	11	1	
,,	Herba, 26	8	None	
,,	Sciortino, 22	11	,,	
,,	S. Giovanni	5	1	
,,	Sta Maria...	5	None	
,,	Marsascirocco, 11	5	1	
,,	,, 11 (A.C.)	11	None	
Zabbar	Xghira, 75	8	1	
,,	Marsascala, 22	8	None	

Name of village.	Street.	Number of goats in herd.	Number of goats which reacted.	Remarks.
Zabbar......	Marsascala, 6...............	18	5	*Micrococcus* recovered from 3.
„	Piazza S. Giacomo, 30 ...	11	1	
„	Sta Maria, 12..............	7	None	
„	Marsascala..................	13	3	
„	Vlo Hassajed	7	1	
„	Xghira, 72..................	5	3	
„	„ 71..................	11	3	
„	S. Domenico, 1	4	1	
„	S. Giuseppe, 68	18	2	
„	Capuccini	14	1	
„	Marsascala..................	6	2	
„	„	14	9	
„	S. Domenico	10	7	
„	Tal Fgura	24	5	*Micrococcus* recovered from 2.
Hamrun ...	Dolori, 29	30	8	
„ ...	Vlo Tal Fatati	18	11	
„ ...	„	35	5	
Axiak	Via Gudja	10	2	
Curmi	S. Pietro.....................	8	1	
Taxbiex ...	Via Sliema..................	5	None	

The principal herds of Lia, Balzan, Attard, Zeitun, and Zabbar were visited, and about one-half of the goats of those villages were tested. The percentage of infected animals is therefore practically accurate. It stands as 12 per cent. for Lia, 19 per cent. for Balzan, 0 per cent. for Attard, 4 per cent. for Zeitun, and 25 per cent. for Zabbar.

As to Hamrun, only three herds were gone through, and there are hundreds of goats in that village. The percentage of infected goats at this place cannot be deduced from our work, but the three herds examined were badly infected.

XII. A CRITICAL EXAMINATION OF THE BLOOD OF PATIENTS IN HOSPITAL, TO DETERMINE IF OTHER THAN MEDITERRANEAN FEVER SERA WOULD AGGLUTINATE THE *MICROCOCCUS MELITENSIS.*

By Fleet-Surgeon P. W. BASSETT-SMITH, R.N.

(Received January 11, 1906.)

The importance of placing beyond doubt the specific character of the agglutination of the *Micrococcus melitensis* when brought in contact with the blood serum of patients, cannot be over estimated, either when the test is used for diagnosis, or for controlling experimental work. There have been cases, from time to time, which have led certain diagnosticians to underrate this modern method of diagnosis. These people would therefore naturally discredit all investigations based on this principle, pointing to cases in which contradictory results have been obtained from the same serum, and to statements that a positive reaction for Mediterranean Fever has been met with in other diseases.

Bearing these facts in mind, I have made a careful examination of 150 samples of blood, taken systematically in the wards of Haslar Hospital, for the purpose, if possible, of demonstrating whether or not the serum of patients suffering from a great variety of diseases other than Mediterranean Fever would give a reaction likely to render a mistake in diagnosis probable. It is unnecessary to describe fully the technique employed, this being so well known, excepting to say that—

1. The tubes containing the blood were centrifugalised, and the clear serum was alone used.
2. The emulsion was made from an agar culture 10 days old of a strain of *Micrococcus melitensis* obtained in November, 1905, from the peripheral blood of a patient now in the hospital, and was used living.
3. The serum dilution of 1 in 30 was made with normal saline solution, using accurately graduated pipettes.
4. The examination was made both microscopically, with a 4-hour limit, and by sedimentation tubes with a 24-hour limit.
5. Controls were made for each batch of tubes, with a serum that reacted perfectly in dilutions from 1 in 30 to 1 in 1000.

The whole examinations were made by myself, but the readings were confirmed by independent observers.

The results are tabulated as follows :—

Nature of disease.	Number of cases tested.	Microscopical.	Sedimentation.
Enteric fever	3	Negative	Negative.
Tubercle of lung	12	,,	,,
,, testicle	1	,,	,,
,, joint	1	,,	,,
Tubercular empyema	1	,,	,,
Pneumonia	5	,,	,,
Bronchitis	2	,,	,,
Bright's disease	3	,,	,,
Hydronephrosis	1	,,	,,
Rheumatism	7	,,	,,
M.C.O.	7	,,	,,
Tonsilitis	3	,,	,,
Dilated stomach, etc.	1	Positive	Positive.
Lead paralysis	1	Negative	Negative.
Appendicitis	7	2 Positive 5 Negative	2 Positive. 5 Negative.
Hemiplegia	1	Negative	Negative.
Epilepsy	3	,,	,,
G.P.I.	1	,,	,,
Alcoholism	1	,,	,,
Aneurism	1	,,	,,
Abscess, local	7	,,	,,
,, liver	2	,,	,,
,, psoas	1	,,	,,
,, mastoid	6	,,	,,
Cellulitis	4	,,	,,
Septic thrombosis	1	,,	,,
Otorrhœa	2	,,	,,
Iritis	3	,,	,,
Keratitis	2	,,	,,
Synovitis	1	,,	,,
Herniotomy	5	,,	,,
Hæmorrhoids	1	,,	,,
Varicose veins	1	,,	,,
Ulcers	2	,,	,,
Fractures	10	,,	,,
Wounds	4	,,	,,
Eczema	4	,,	,,
Gonorrhœa	5	,,	,,
Gon. rheumatism	2	,,	,,
Syphilis 1	16	,,	,,
,, 2	7	,,	,,
Normal blood	2	1 Positive 1 Negative	1 Positive. 1 Negative.
Totals	150	4 Positive 146 Negative	4 Positive. 146 Negative.

It will be seen that the blood of 41 pathological conditions was tested, and that, in all but four cases there was no evidence of agglutination of the *Micrococcus melitensis*. Of these four positive reactions, two appendicitis cases had lately returned from Malta Hospital, and were running a regular undulant temperature, and had undoubted

Mediterranean Fever. The third case was a sick berth steward, who had Mediterranean Fever two years and 10 months ago. The fourth was a long time in Malta Hospital, where gastroduodenostomy was performed, and, though there is no definite temperature chart of Mediterranean Fever, I have no doubt that he was, like so many others, infected by the micro-organism there. His temperature is now irregular.

All these examinations, therefore, gave an *absolute negative* to other than Mediterranean Fever blood causing agglutination of the *Micrococcus melitensis* in a dilution of 1 in 30. The following points were also investigated with regard to this reaction :—

Will Lower Dilutions give Erroneous Results?—Ten of the already-used samples of blood were tested in dilutions of 1 in 5, 1 in 10, and 1 in 20. In one case only was there any reaction, an abscess of the knee, which agglutinated up 1 in 10.

Are the Agglutinating Properties Destroyed by Keeping the Blood?—Some serum from a tube of blood, which had been taken from a patient in November, 1901, was tested in the same manner.

	Dilution.			
	1/10.	1/20.	1/40.	1/200.
Microscopic	+	+	+	+
Sedimentation	+	+	+	+
Control, normal blood...	—	—	—	—

Result.—Four-year old blood serum agglutinated perfectly.

Are the Agglutinating Properties Destroyed by Heat?—A portion of the control-serum was heated to 60° C. for 10 minutes, and tested as before.

Result.—A good reaction, both microscopically and in sedimentation tubes, at 1 in 30 was obtained.

Are Dead Cultures Reliable for any Length of Time?—Using the control-serum, the following dead emulsions made in the laboratory were tested, dilution 1 in 30.

	Microscopical.	Sedimentation.
1. Agar emulsion of *Micrococcus melitensis* isolated at Haslar, heated to 65° for quarter of an hour, 0·5 per cent. formalin. Made 9.11.03	+	+
2. Agar emulsion from strain, given by Professor Wright, Netley. Made 8.11.04	+	+
3. Agar emulsion, from Haslar strain 2. Made 20.3.05	+	+
Control, normal blood	–	–

Thus, dead cultures made here more than two years ago were perfectly reliable, though the reaction is less rapid than when living ones are used.

Reliability of the Agglutination Reaction in Mediterranean Fever.—Here it may be stated at once, that in acute cases, I have found the reaction unmistakable, the serum in fairly high dilutions, acting on the *Micrococcus melitensis* almost immediately, clumping completely, and being generally easily visible with a 1-inch objective. With chronic cachectic cases of more than four months' duration, so commonly met with in Haslar Hospital, it is different, the reaction being often incomplete, slow, and only obtainable in very low dilutions, as shown by the following cases:—

1. J. W. Onset of the fever, April, 1904; returned to the Mediterranean in 1905: immediate relapse. In November, 1905, the blood only agglutinated in dilutions of 1/10, yet the *Micrococcus melitensis* was in the same month isolated from his blood.

2. J. P. Onset April 19, 1905; now intense emaciation and neuritis. In November the blood agglutinated up to 1/10; with 1/5 the reaction was immediate.

3. T. S. Onset August, 1905; great emaciation and neuritis. In November the blood only reacted up to 1/10.

From these results, and from a great number of the same kind, I have formed the opinion that, when using the 1/30 dilution (if the technique is properly carried out), a positive agglutination reaction may be considered conclusive of Mediterranean Fever, past or present. On the other hand, it would not be correct to state that the patient is not suffering from Mediterranean Fever, when an examination of the blood gives a negative reaction with this dilution. I believe the chief sources of fallacy are—

1. Faulty technique; incorrect dilutions, too long time, etc.
2. Faulty cultures; containing false clumps before use, etc.
3. Faulty observations; mistaking false clumps for true agglutination.
4. Faulty history; the patient having previously had the disease.

The sedimentation test appears to me to be the least likely to give rise to errors, provided *clear* blood serum is used, and the emulsion be sufficiently strong to give a visible pellet at the bottom of the tube.

XIII. — REPORT ON THE PREVALENCE OF MEDITERRANEAN FEVER AMONGST BRITISH TROOPS IN MALTA, 1905.

By Lt.-Col. A. M. Davies, R.A.M.C., Member Mediterranean Fever Commission.

Introductory.

On taking up the investigation of Mediterranean Fever in its epidemiological aspects, at the beginning of June, 1905, after consideration of the various lines on which such an inquiry might be best carried out, I became convinced that the most profitable course to adopt would be to devote the greater part of the time at my disposal to the study of the disease as it manifested itself amongst the British troops. Dr. R. W. Johnstone having made a general survey of the circumstances in regard to the whole population, civil, naval and military, up to the time of writing in the previous year, it seemed that a more detailed consideration of one branch of the subject—even though in numerical importance only a small one—might lead to useful results. I was the more inclined to take this course for two reasons: first, Dr. Johnstone had made such a comprehensive survey of the "sanitary circumstances and prevalence of Mediterranean Fever" in the previous year, that there was no need for another inquirer to go over the same ground a few months later; and, secondly, the fact that, in regard to the military population the statistical data—which are the foundations of an epidemiological inquiry—are to be relied on almost implicitly; while in regard to the population of Malta generally, our knowledge of the actual distribution of the disease, both in place and time, is at present so very imperfect, that the difficulties in the way of discovering the causative factors are extreme. Dr. Johnstone has mentioned this in his Report (p. 11). The notification of Mediterranean Fever throughout the population generally is extremely inaccurate, "only severe cases are notified, and not always these." Now, whether in regard to differences of prevalence in different *places*, or variation in incidence at different *times*, unless there is good ground for trusting to the accuracy of the records of prevalence (*i.e.*, the notifications), the labour expended on inquiring into apparent outbreaks may be entirely thrown away.

The military population concerned is approximately 9000; if every case of Mediterranean Fever occurring in this population during even a single season were accurately recorded as to time and place of onset, and as to all the surrounding circumstances that could be regarded as bearing on the problem, a body of facts ought to be forthcoming that would at any rate make some addition to our knowledge of the causation of the disease; if not of the actual cause, at least of the conditions favouring the effectual operation of the cause. There seemed to be every likelihood, from the behaviour of the epidemic in May, that a large number of cases would occur amongst the troops during the hot season; and that the amount of material for investigation would be large enough to make it justifiable to limit the inquiry to this particular line. From January 1 until September 30, 1905, there occurred 487 admissions for Mediterranean Fever from among the British troops, and it is to the study of this epidemic that I have chiefly given attention.

Three principal lines of investigation presented themselves: (1) It appeared to be necessary to make a detailed sanitary survey of the actual conditions under which the troops are living in the various barracks in the Maltese Command: I accordingly visited repeatedly every individual barrack, and examined into its situation, construction, water supply and drainage, as well as any other matters that seemed to need investigation. In the present state of our knowledge, or want of knowledge, as to the causation of Mediterranean Fever, it did not seem allowable to neglect any point of general sanitary importance, even though its connexion with the prevalence of this disease did not seem to be obvious. It does not, however, appear necessary to encumber this report with all the detailed results of this investigation, referring in many instances to somewhat minute points of sanitary engineering practice or military administrative procedure; a brief summary only of the more important points is set forth in *Section I*, the details forming a separate Report presented to the Director-General, Army Medical Services.

(2) Concurrently with this the course of the epidemic was noted, and as far as possible inquired into at the time, and on the spot, week by week; the intention being to record, as accurately as might be, the actual incidence of the disease in the various barracks and in the various regiments. As far as I have been able to ascertain, it has hitherto been the practice to allocate the cases of Mediterranean Fever to the barracks from which they have been admitted; the object of this part of the special inquiry has been to trace the origin of these cases with greater exactness, ascertaining the movements of the patient previous to admission to hospital, and endeavouring to locate not merely the barrack, but the room, which he had been occupying for some time before admission. In this way it was hoped that some facts would be ascertained that would serve as indications as to the cause, or rather the mode of spread, of the disease. These results are summarised in *Section II* of this Report.

(3) As another means to the same end, the attempt was made to

interview personally every Mediterranean Fever patient, and elicit all the information procurable as to his habits, occupations and so on previous to being taken ill. Unfortunately some patients were too ill to be questioned, some were invalided before I was able to visit them; so that from one cause or another not more than 187 were actually interviewed. I much regret that I was not able to carry this part of the inquiry further.

The information obtained by these three lines of inquiry is summarised in *Section III*, in which an attempt is made to correlate the various facts, and ascertain what relation exists, if any, between Mediterranean Fever prevalence and this or that sanitary condition. The conclusions arrived at, and certain recommendations submitted, are set down in *Section IV*.

Incubation Period.—A great difficulty, that has been experienced by all inquirers into the epidemiology of Mediterranean Fever, arises from the uncertainty that exists as to the length of the incubation period. Hughes, from his own experience, and from a study of the literature of the subject up to the time of writing (1897), considered that it might be "as short as three days in some cases. Probably 3 to 10 or 15 days is near the mark in cases where the first febrile onset is noted." Dr. Johnstone states that "the general impression amongst Maltese medical men seems to be that the usual incubation period is not more than 8 or 10 days." In five laboratory cases of human infection "in places where there was no prevalence of Mediterranean Fever, and no apparent source of infection other than in relation with infective material in the laboratory," the periods were respectively 5, 6, 8, 15 and 16 days. These infections appear to have all been by inoculation; all were accidental, except the one with 16 days incubation, which was definite and purposeful. In the previous Reports of the Commission instances are recorded of infection by inoculation manifesting itself after 5 and 8 days in monkeys (Gilmour), after 6 days in goats (Shaw), after 6, 10 and 13 days in monkeys (Horrocks); in all these cases the agglutination test has been taken as the proof of infection. By the same test infection by feeding has been demonstratnd in monkeys after about 24 to 32 days in several cases (Horrocks), and in one case, in a goat, apparently after 21 days (Horrocks). There is a sufficient agreement in these results to lead to the supposition (which is on other grounds reasonable) that with infection by inoculation the incubation period is shorter than by ingestion into the alimentary canal; with inhalation of infected dust (monkeys) the incubation period is uncertain, 17 to 31 days or less (Horrocks).

How far the period of incubation observed in animal experiments can be considered to hold good in the case of man is doubtful; the doses used in the laboratory have been enormous; and as it would be unreasonable to suppose that the quantitative element has no effect on the rapidity of development of the disease, the laboratory limits in all probability require to be considerably extended when the question of human infection in the ordinary way or ways has to be dealt with. As we are at present ignorant of the path of infection in man, we must assume that incubation may be as short as about a week, and may be as long as about five weeks, according as the infection is by inoculation or by feeding. But considering the very much smaller doses of pathogenic material likely to be actually absorbed than those used experimentally in the laboratory, it seems probable that not less than a fortnight should be regarded as a minimum period, and that the maximum period should be extended up to about six weeks at least.

In the absence of any more definite guidance I have adopted a fortnight as the most likely incubation period *at the least*, and a further fortnight as *probably* needful to be allowed, for incubation. That is to say, if a man moves from Barrack A to Barrack B, and subsequently develops Mediterranean Fever, I consider that if his illness commences within a fortnight of his change of residence, the infection was *almost certainly* contracted at A; while if it commences within a month of the move, it has *more probably* been contracted at A than at B. I have not been able to ascertain any shorter instances of incubation than the two quoted by Dr. Johnstone (*Report*, Part II, p. 15), of 8 and 11 days respectively; and the behaviour of the epidemic in the Essex Regiment (detailed in *Section II*) points to about five weeks as probably the longest usual interval between inspection and onset of illness. Further observations are much needed in regard to this matter.

Diagnosis.—All cases admitted to the military hospitals in Malta, that have been returned as Mediterranean Fever, have been diagnosed as such, both by their clinical features, and by the results of the agglutination test; this has been invariably applied, and no case has been returned as Mediterranean Fever unless the reaction has been definite and complete.

SECTION I.

The most important points in regard to the sanitary condition of the barracks in Malta may be shortly summarised under the general headings of situation, construction, water supply, and drainage.

In Valletta itself, and Floriana, there are seven separate barracks, all more or less antiquated in their plan and construction.

In *Lower St. Elmo* an infantry battalion (2nd Essex Regiment until July, 1905, then 1st Lancashire Fusiliers) is accommodated in a part of the fortress that occupies the extremity of the promontory separating Marsamuscetto or Quarantine Harbour from the Grand Harbour.

The fort adjoins the sea on two sides, but, being excavated in the rock, the barracks are entirely deprived of any advantage from this proximity; while on the south they adjoin the most densely inhabited part of the city, and on the east are shut in by the more elevated part of the fort, called Upper St. Elmo. The barrack rooms, 52 feet in length, are casemates arranged in two tiers, and are very imperfectly ventilated; they accommodate 23 men in each, and the cubic space is barely 600 feet per head. The drinking water supply is ample; a second quality of water is provided for ablution, not always in quite sufficient quantity; sea water is laid on for flushing purposes. The latrines are water-closets of good pattern, and have recently been fitted with new automatic flushing apparatus; the urinals are of the ordinary type, having a scanty flush of water, and being also treated with a coating of kerosine oil. The drainage has been remodelled in recent years, and is satisfactory; the soil pipes are ventilated, and accessible inspection chambers provided at junctions of the underground drains, which discharge into the Civil Government sewer.

The water supply and drainage arrangements of these barracks are in the main satisfactory; their construction is very insanitary, the ventilation bad, and the cubic space insufficient. Although it is the practice in Malta generally to issue tentage during the summer months, sufficient to allow of 25 per cent. of the troops sleeping out of the barrack rooms; since June, 1903, Lower St. Elmo has been excepted from this privilege, for reasons which I have not been able to ascertain. These barracks are, in my opinion, more in need of this thinning-out process than any others in the whole island. The accessories are fairly satisfactory, except that one of the cookhouses adjoins a stable.

Upper St. Elmo adjoins the last mentioned on the east, is at a higher level, and is in every way more advantageously situated, being freely exposed either to the sea or the harbour on three sides. The barracks are occupied by two companies of Royal Garrison Artillery; but, the quarters being insufficient for their accommodation, many of the men live and sleep in tents. A lower portion, consisting of two tiers of small casemate rooms, is occupied by 96th Company R.G.A.; the rooms, being only about 25 feet long, are not difficult to ventilate, but the cubic space allowed (440 to 536 cubic feet per head) is very small. The upper portion consists of rooms of more modern construction, and not of casemate shape; but the cubic space, about 550 cubic feet per head, cannot be considered as sufficient. The water supply is satisfactory. The latrines are not satisfactory; the lower latrine, used by 96th Company, has recently been fitted with an automatic flush, but it is in a dark and cramped situation; the upper latrine, used by 65th Company, was in a bad state at the time of my visit, the flushing arrangement being completely out of order, and the pans full of excreta. The urinals are scantily flushed; oil has not been taken into use. The drains are generally in a satisfactory condition, accessible inspection chambers being provided where required; some points of detail need attention in regard to the drainage of the new sergeants' mess.

The barracks generally are better than Lower St. Elmo; but the continual use of tents in this very confined situation must lead to fouling of the ground.

St. James Cavalier is a small barrack, accommodating a detachment of 138 men belonging to the Royal Garrison Artillery stationed in Upper St. Elmo, at present 65th Company. It is situated in the upper part of Valletta, the barrack rooms being casemates similar to those in Lower St. Elmo; two of the rooms are 51 feet in length, with most inadequate openings for ventilation; they are, however, authorised to accommodate 32 men in each, giving a cubic space of only 535 feet per head, which is quite insufficient; four other rooms are not so long, and therefore not so hard to ventilate; all the six rooms are authorised to hold more men than there is actually space to accommodate, unless the bed-cots are arranged in three rows, a practice which would be most insanitary, and is universally condemned. At least 750 cubic feet should be allowed per head; and, even with this increase, it is doubtful if No. 6 room would be reasonably fit for occupation. The drinking water supply is satisfactory, also that for ablution; but for latrine flushing it has had to be carried up by hand. Throughout the greater part of the past summer all the water supply for the latrine has had to be carried up by hand, as a regimental fatigue, the result being that a minimum quantity has been provided, and the condition of the latrine has been insanitary. It is absolutely necessary that water should be laid on to a latrine in a permanent barrack. With this exception the drainage arrangements are satisfactory. The situation is bad, and the construction of the barracks insanitary.

Floriana Barracks, including Salvatore Counter Guard and Notre Dame Ravelin, are occupied by a battalion of infantry, at present the 1st Royal West Kent Regiment. They are situated on the north side of Floriana, and within the outer line of the landward defences of Valletta, of which they form a part. The *old* portion of these barracks consists of a range of 12 casemate rooms, about 80 feet in length, each accommodating 30 men, with an allowance of from 700 to 1203 cubic feet per head. In casemates of this length, with no window openings except at the two ends, it is impossible to secure proper ventilation. At present the barracks are not crowded, as the accommodation is sufficient for 920, and the battalion does not number more than 780. A peculiarity of these barracks lies in the circumstance that the Malta Civil General Hospital occupies the upper part of a building, on the ground floor of which are the regimental offices, stores, &c. There is no communication between the ground and upper floors, and the drainage of the hospital is quite distinct from that of the barracks, but it is most undesirable that such a building, into which infectious cases (*e.g.*, possibly cholera or plague-striken sailors) might be admitted, should form part of a structure occupied as a British barrack.

The *New* Barracks consists of three blocks of two-storey buildings, each accommodating one company, that have only recently been completed; the rooms are well arranged, according to modern principles, each holding 26 men, with an allowance of 755 cubic feet per head.

The rooms in *Salvatore Counter Guard* are small casemates with no through ventilation at all, and with a scarp wall distant only 12 yards from the front of the rooms; the movement of air must be very limited at any time, and adequate ventilation impossible; in spite of this, the allowance of cubic space is less than 600 feet per head; neither have the men been thinned out at night during the hot weather.

Notre Dame Ravelin consists of a range of 16 small rooms on the ground floor, accommodating 5 men in each, with an allowance of 900 cubic feet per head; and of seven huts, each for 18 men, with 600 cubic feet per head. These are all well ventilated, and of satisfactory construction. The huts stand on a concrete platform, and are slightly raised from the ground.

There is a good supply of No. 1 water for drinking, and No. 2 water for ablution purposes; for flushing the supply (No. 2) is sometimes defective in the Old Barracks; a larger tank and separate supply for the latrine seem to be required. The drainage of all these barracks is of modern construction, and, in the main, satisfactory. One of the latrines in the New Barracks was in bad order at the time of my visit, partly owing to a structural defect; and in several places the internal surface of the drains is uneven, leading to obstruction, or retardation of flow; gully gratings are in some places deficient. The urinals are treated with oil, and also flushed with water.

Of these barracks it may be said that the New Blocks and Notre Dame Ravelin are satisfactory, but that the Old Barracks and Salvatore Counter Guard are bad, and incapable of being made suitable for accommodating troops. Great complaints are made of the extensive fouling of the ground in the neighbourhood of these barracks, where a large number of Maltese labourers are employed in road-making, etc. The troops have no control over these people, and the civil authorities appear to be powerless in the matter.

St. Francis Barracks, Floriana, are a small range of barracks of very old type, partly on one, partly in two stories, occupied by a company of Royal Engineers. Nos. 3 and 4 rooms on the ground floor are large apartments, 66 × 29 feet, authorised to accommodate 45 men in each; the ceiling is arched, and, if the height be reckoned as 26 feet, the cubic space per head amounts to 1079 cubic feet, as shown in the Barrack Return; but if 12 feet of height only be reckoned (according to the general rules for calculating cubic space), the amount per head is only 500 feet. The means of ventilation are insufficient. Nos. 6 and 7 are large rooms on the upper floor, fairly well provided with windows and ventilating openings, but difficult to ventilate, on account of their excessive width, 40 feet. These are very unsatisfactory barracks; if they are to continue to be occupied, a cubic space of 750 feet should be allowed, and no greater height than 12 feet should be reckoned as available for ventilation purposes. The water supply is satisfactory. The latrine and urinal are of very old pattern, and require reconstruction; the drainage is modern, and in good order.

Marsamuscetto Barracks, occupied by the Army Ordnance Corps, consist of two rooms on the ground floor, each accommodating 41 men; the rooms are arched casemates, 72 feet in length, having windows only at one end; adequate ventilation is impossible, yet the effective cubic space (reckoning a height of 12 feet) is only 540 feet per head. The number of actual occupants is at present less than half the allotted number, so that there is no overcrowding; but the building is unsatisfactory. The latrine is within 20 feet of the cook-house; it is flushed only twice a day; a third flush at least is required. The urinal is intermittently and scantily flushed with water. The drainage is in good order.

The *Old Laboratory Barracks*, occupied by Army Service Corps, Army Pay Corps, Military Foot Police and Garrison Staff, consist of four rooms at an upper level, and two at a lower level; the upper ones are arched casemates, with very inadequate ventilation; the lower ones are in a very cramped and confined situation. The latrine is exceedingly cramped, dark, and ill-ventilated. The barracks are said to be condemned. They are incapable of being made really satisfactory from a sanitary point of view. The water supply and drainage are inadequate.

Manoel Fort and Hutments together accommodate an infantry battalion; up to the beginning of June they were occupied by the 1st Rifle Brigade, since then by two companies of the Lancashire Fusiliers. The situation, on a small island in Marsamuscetto Harbour, is favourable, with free air space all round. Seven of the barrack rooms in the fort are casemates, about 32 feet in length, each accommodating nine men, with 600 cubic feet per head; being small rooms their ventilation would not be unsatisfactory, but that the blank wall of the chapel and officers' quarters is only a few feet distant from the front of the rooms, and materially interferes with the free passage of air. Three other rooms, accommodating 36 men in all, are free from this disadvantage. The hutments consist of 28 huts, each accommodating 18 men; they are well raised from the ground on pillars; the surface beneath is cemented, clean, and dry, and they are not overcrowded. The water supply is satisfactory; No. 1 water is used for drinking and washing in the hutments; in the fort, No. 2 water is collected in tanks in the rainy season, and used for ablution and flushing purposes. The latrines are all on the dry earth system; a double set of buckets is provided, but the excreta are removed only once a day, in the early morning. The water drainage system takes urine and ablution water, and discharges direct into Marsamuscetto Harbour; it is of modern construction, and satisfactory. Except for the retention of the dry earth system, these barracks are in a good sanitary condition. A connexion should be made with the Civil Government sewer as soon as possible.

Tigne Barracks, occupied by three companies of Royal Garrison Artillery, consist of the old fort, two new blocks of quarters, and 15 huts; in addition are married quarters, offices, institutes, &c., all of modern construction. The situation is excellent, having the open sea to the north and east, and Marsamuscetto Harbour to the south. The fort contains only a few small rooms; one on the upper floor is well ventilated; seven on the ground floor are at a lower level surrounded by the fort wall, and badly ventilated; only two are in present occupation, and all (it is said) will be evacuated shortly. The two new blocks, each accommodating 100 men, are two stories in height, and satisfactory in every way; except that the urine tubs have to be carried *through* the rooms on the upper floor from the verandah at back to the staircase in front, thereby leading to fouling of the floor with possibly infective material. The huts accommodate 18 men in each, are well raised off the ground, which is concreted and easily kept clean, and are not overcrowded. In the summer 25 per cent. of the men sleep in tents; in 99th Company no trestles or bed boards were supplied, and the men's mattresses were placed on the ground; this should not be allowed.

At present No. 1 water is used for all purposes, 20 gallons per head being allowed for everything. Until recently the latrines were on the dry earth system; now that a water latrine has been erected, it will probably be necessary to draw on the rain-water tank beneath the barrack square; but it would be better to lay on a supply of flushing water. In the fort the ablution water and urinals drain into a system that eventually enters the open sea; a dry earth latrine remains in use, which is regrettable. For the rest of the barracks an excellent modern drainage system has just been completed, discharging into the

Civil Government sewer. Two dry earth latrines still remain in the western part of the barracks, one being for the use of the school; the other is no longer required; this should be closed, and a water latrine provided for school use. A large new latrine has just been opened to the north-east of the barrack square, containing 34 seats; this is flushed three times daily, at present with No. 1 water. It is an important question, affecting several barracks, whether this No. 1 water, the supply of which is very limited, should be used for flushing purposes. There is great danger of the quantity being restricted, leading to an offensive and insanitary condition of the latrines; it is also very doubtful whether its use for this purpose is justifiable under the circumstances obtaining in Malta. I am very strongly of opinion that a supply of flushing water should be laid on to all latrines, and used in great abundance; and that No. 1 water should only be used (as a rule) for drinking and cooking purposes. In the present case the greatest care should be taken to prevent this new latrine, connected with a new system of drainage, from degenerating into the filthy and dangerous state that so many of the latrines in Malta have been allowed to get into, principally through deficiency of a proper supply of water, in some instances unavoidable, in other instances the result of neglect.

The urinals are treated with paraffin oil and lampblack, and water flushing is used as well. The new urinal contains 26 stalls, the authorised allowance (4 per cent.) for the number of troops occupying the barracks. It is extremely inconvenient to collect all the urinals together in one place; and when so many stalls are provided in one range most of them are not used; not more than six or eight stalls are ever required in one range; the rest are useless, and lead to a great waste of water.

Except for the minor points of detail, these barracks are satisfactory in every way as regards situation, construction, water supply, and drainage; but care must be taken in regard to the matter just mentioned in order to maintain this satisfactory condition; if water is stinted for flushing purposes, the state of things will be very different.

To the south-east of the Grand Harbour, and elevated a considerable height above the sea level, lie the Verdala Barracks, a chain of fortifications called the Cottonera Lines, and at the harbour's mouth Fort Ricasoli.

Verdala Barracks, occupied by an infantry battalion (2nd Hants), consists of 66 small casemate rooms, each about 25 feet in length, and accommodating 10 men; they are disposed on two floors and in two rows; being small rooms, and in a fairly airy situation, their ventilation presents little difficulty; the cubic space allowed is, however, only 515 feet per head, which is not sufficient; the accoutrement shelves are fixed to the walls in a continuous line, and the bed-cots are only 12 inches apart from each other. Drinking water is laid on, and the supply is ample; for washing, No. 2 water is pumped up by regimental fatigue; until July, 1905, all the water required for flushing purposes was also similarly pumped up; now, however, salt water is laid on for this purpose, but the supply at the time of my visits was uncertain, and frequently No. 2 water had to be pumped up, regimentally, as before. The regimental latrine is situated rather near the cookhouse; it is of Jennings' continuous pipe pattern, and until recently was only flushed twice a day; it is now flushed three times daily, at 9.0, 2.0, and 5.0, and this is hardly sufficient. When a proper supply of salt water for flushing is available, it should be done four times a day. The urinal has 14 stalls, aggregated together, many of them being never used; both water flushing and oil application have been practised, the former ineffectually; the stone floor is very uneven and requires putting in order. The underground drainage is modern and, on the whole, satisfactory. Some additional ventilation to the system would be advisable, and provision for automatic flushing instead of the present inefficient method of flushing by hand with barrels of salt water, when it is available. The sanitation of these barracks has been well looked after, under circumstances of considerable difficulty.

The quarters which together make up the *Cottonera Lines* are, St. Clement's Bastion, Zeitun Gate, Polverista, St. John's and St. Paul's Bastions, Couvre Porte, Vittoriosa, Fort Salvatore, Zabbar Gate, and Notre Dame; accommodating in all about 780 men, that is, an infantry battalion. In the early part of 1905 they were occupied by the Royal Sussex, and then by the Lancashire Fusiliers; since the departure of this regiment for Lower St. Elmo they have been mostly vacant, except for detachments of the Hants Regiment in Polverista and St. Clements. All of the barracks are old and defective in many ways; proper ventilation is very difficult; if their occupation is continued, at least 750 cubic feet per head should be allowed, reckoning only a height of 12 feet as of any value for ventilation purposes. The small rooms at Zeitun Gate are fairly sanitary; but the larger ones, Nos. 5, 6, and 7, measuring about 32 × 20 feet, without any windows except in the front wall, are impossible to ventilate satisfactorily. The rooms in Polverista, which are arched casemates, 33 feet long, accommodating 14 men in each, are also very inadequately ventilated. The small rooms in St. John's and St. Paul's, although inconvenient, are not difficult to ventilate. At Couvre Porte, No. 11 room has no window at all, and is unfit for occupation. Vittoriosa has three large rooms, each accommodating 34 men, which are airy and well lighted, though a proper cross ventilation is not possible. The three large rooms at Fort Salvatore, each measuring about 80 × 20 feet, cannot be adequately ventilated by the very small openings that at present exist. At

Zabbar Gate the two large rooms, though light and airy in appearance, are very hard to ventilate, on account of their great width, 36 feet. Notre Dame, consisting of eight small rooms, is fairly satisfactory.

The water supply of these small barracks is a matter of some difficulty, and in connexion with the latrine arrangements requires more attention than has hitherto been given to it. No. 1 water for drinking is laid on, and is sufficient and always available. For washing purposes and for flushing latrines and drains No. 2 (collected rain-water) has, until last July, had to be pumped up by regimental fatigues; at Polverista the pump has broken down several times (twice during the time I was making my visits to the barracks in July and August); the labour of working this pump appears to be excessive. I was informed that a fatigue of nine men, working six hours a day, was required. On three occasions I found the latrine empty of water, but fouled with excreta; this appeared to be a not uncommon occurrence. It has been the same with the other outlying barracks. Salt-water flushing is in course of being provided, but so far the supply has been uncertain. Until an ample supply of water is available for adequately flushing the latrines—at least three times a day—and for keeping the extensive system of drains in good order, these barracks are not fit for occupation.

The drainage generally is modern and satisfactory in construction. There has been considerable complaint of bad smells in front of Polverista; the drains are properly constructed, but more water is required for flushing the verandah drain and down pipe leading into the collecting drain below.

Fort Ricasoli lies at the mouth of the Grand Harbour, on its eastern side, in an ideal situation; it is open to the Mediterranean and the harbour in three directions, and has the open country to the east, with no villages near. An ample supply of drinking water is laid on, used also for ablution purposes, and salt water is drawn from the sea for drain flushing, by a pump independent of any other supply. The drainage passes direct into the sea, by three independent systems of drains, which have been laid down within the last few years according to modern principles, and which are in good order. Some additional provision of fresh air inlets would, in my opinion, be desirable. The latrines and urinals are well kept, a mixture of tar and kerosine oil being used for the latter; one latrine was found to be without any water (but full of excreta) on one occasion, owing (so I was informed) to choking of the branch supply pipe; even under the quite exceptionally favourable conditions as regards water supply at Ricasoli, strict supervision and watchfulness are necessary.

The barrack rooms are mostly large and lofty, having plenty of window space on one side (facing the square), but no openings on the other (which is the outside of the fort); five such rooms are each over

100 feet in length by 22 feet wide, accommodating between 50 and 60 men in each; being about 23 feet in height, the cubic space per head (about 1100 feet) is large; but it is not all available for ventilation purposes, not more than 12 feet of height being really effective; on account of this height and the width of the rooms, it is difficult to get a free change of air. The bed-cots are placed very close together. No. 1 room, 80 × 22 feet, has two windows only on one side, and a doorway at one end; there are no windows on the other side or at the far end, which is quite unventilated.

The actual barrack accommodation is for 480; but three companies Royal Garrison Artillery are normally stationed here, with a strength of about 700; about 120 are quartered in outlying forts, and about 150 in tents pitched in the barrack square, occupied all the year round. In the summer 25 per cent. extra tent accommodation is drawn. Although the construction of the barracks is not sanitarily satisfactory, the general good hygienic conditions of Ricasoli, and its fine airy situation, should make it a healthy station.

Outlying Forts on the eastern side:—Small bodies of men are accommodated in several small forts in this direction. In every case the cubic space is sufficient, though, from military exigencies, ventilation is restricted; drinking water is laid on to all the forts; but for some months during the past summer this pipe supply has been cut off, and the water has been carried out to the forts in barrels. The drainage arrangements are generally satisfactory, as regards slop water and urine; dry earth latrines are in use. These require to be more carefully supervised, and the removal should be more frequent.

The barracks hitherto mentioned have been, in the main, old buildings, dating from a pre-sanitary era, though added to from time to time, and with drainage and water supply modernised more or less efficiently. On the north side of the island are two extensive ranges of barracks, one of which, St. George's, was built in 1860, and has since been added to, and the other, St. Andrew's, has only been completed in the year 1905. Each of these accommodates an infantry battalion.

St. George's Barracks, occupied by the Royal Dublin Fusiliers, consist principally of single-storey blocks of small barrack rooms, accommodating 13 men in each, with 605 cubic feet per head; these are of good construction, and very fairly well ventilated; the accoutrement shelves are fixed to the walls in a continuous line, and the bed-cots are only 12 inches apart from each other, which causes what may be called an artificial overcrowding at night. There are two new double-storey blocks of quite modern design, airy, well ventilated, and well arranged; the rooms accommodate 16 or 18 men in each, with an allowance of 750 cubic feet per head. A defect in the arrangements is that the urine tubs have to be carried through the rooms on the upper floor, from the back to the front (as at Tigne), thereby leading to fouling of the floor with urine, which is most undesirable.

No. 1 water is laid on for drinking and also for washing, the supply being quite ample; it is also laid on to the married quarters for flushing purposes as well. In the barracks sea water is pumped up for latrine and drain flushing, but owing to defects in the pumping arrangements, the quantity of water provided has been insufficient, and the latrines have not been properly cared for. The drainage is of modern construction throughout, and is well looked after; the latrines are flushed three times a day if water is available; the urinals are in good order, a mixture of lampblack and kerosine being applied. There are several minor defects, which might be easily rectified; one frequent source of drain obstruction in Malta is the readiness with which sand and gravel are blown into and washed into and through gullies; in these barracks, which are well exposed to the wind, this occurs to a considerable extent, and causes some difficulty in keeping the drains clear; raised parapets, to keep out surface washings, and deep traps might be supplied in some places with advantage.

St. Andrew's Barracks were only completed in the early part of 1905, and were taken over by the 1st Battalion Rifle Brigade in June. They consist of nine double-storied company blocks, the rooms accommodating 14 men in each, with a cubic space of 800 feet per head. They are satisfactory in every detail, except for the necessity of carrying urine tubs through the rooms on the upper floors. The water supply is No. 1 for all purposes. The drainage is satisfactory in its main features, but there are several points of detail that require attention, such as the provision of accessible manhole covers (instead of cemented slabs), easing off of right-angled junctions, etc.

Pembroke Camp is a musketry camp near St. Andrew's Barracks, occupied by parties of men from various regiments in succession throughout the whole year, as many as 800 or 900 being sometimes under canvas at once. Its sanitary condition is very unsatisfactory. The ground is rocky and uneven, and difficult to keep clean; the sites of the tents are never, or hardly ever, changed. There is one dry earth latrine of 26 seats for the whole camp; this is not sufficient accommodation for the numbers that are frequently present; the latrine seats are badly constructed, being too high (or the pails placed too low); fouling of the ground with urine results. The pails are removed only once a day, between 4 and 5 a.m., the result being that for the greater part of the 24 hours the air of the camp is fouled by excretal emanations; flies are also attracted in great numbers. The woodwork of the latrine is in bad repair. The urinal consists of a plain marble slab like a native convenience; it is flushed with water and no oil has been applied. At the north-west end of the camp is a cesspit, connected with the officers' W.C., apparently unventilated, and in close proximity to the water tank and officers' cookhouse. A water drainage system is now being carried out, and this cesspit should be removed.

Pembroke Camp is in a very bad sanitary state, not due to any want of care on the part of the camp authorities, but on account of obvious defects of design and construction in what may be called minor details. A small *permanent* sanitary staff should be provided to keep the camp in as sanitary a condition as may be possible, and lessen the difficulties resulting from the constantly shifting character of the population.

In regard to the *Outlying Forts* in the Western District the same remarks apply as to those in the Eastern, except that No. 1 water is laid on in each case, and is ample in quantity. The dry earth system is in use, and is fairly satisfactory, except at Maddalena, where the accommodation is insufficient, there being only two latrine seats. Everywhere removal only takes place once a day, which is not enough. A modern drainage system for slop water, &c., has been laid down in each case.

Imtarfa Barracks consist of four large blocks, accommodating 233 in each, and four smaller blocks, accommodating 110 in each, all of two stories; the rooms are constructed for either 16, 18, or 20 men, with a space of 750 cubic feet per head. They are excellent barrack rooms in every way, well built, and with every convenience. No. 1 water is laid on for drinking and washing; rainwater is collected in underground tanks, and pumped up regimentally for cleaning and flushing purposes. The latrines have hitherto been on the dry earth system, but a water carriage system will be introduced very shortly. A complete system of drainage has been constructed, to which the latrines can be readily connected up. The dry earth latrines were in a satisfactory condition at the times of my visits, but I was informed that this had not been the case earlier in the summer, and that it had been found necessary to employ regimental fatigues to apply the dry earth thoroughly. It is difficult to get the dry earth system properly carried out anywhere (though principally a matter of regimental discipline), but the difficulty is much increased in the case of a body of men who have been accustomed to the use of water latrines, that require no attention on the part of the individual. In the present case a rather considerable prevalence of enteric fever has been due, in all probability, to faulty carrying out of the dry earth method at Imtarfa. The latrines are emptied by contract once only in the 24 hours, about 2 A.M.; during the greater part of the day, therefore, they are full of excreta, and the air of the barracks proportionately fouled; flies are quite a plague in some parts of the lines, a fact which is always significant and generally of ill omen. The urinals are treated with a mixture of colza oil and tar; this has acted most satisfactorily, applied once a week; the urinals here were in a better state than any others in Malta at the times of my visits. The underground drainage system is satisfactory on the whole; at one or two places the fall appeared to be hardly sufficient, *e.g.*, at the north-west corner of the canteen a considerable amount of deposit was found; there was also a good deal of deposit in the main collecting drain at the east end of the barracks, north of the junction with No. 1 cookhouse drain; in both places this has, I understand, occurred before, more than once. Additional flushing is required, and careful supervision to see that no stoppage takes place.

Some surface drains which take the washings of the verandahs of married quarters lead into the foul drainage system, passing through a gully trap to cut off the foul air. Such is the case in M, N, O, and P Blocks, Married Quarters. But the verandahs of these blocks are not habitually, and probably very seldom, if ever, washed down with water; consequently in dry weather no water gets into this gully, or at least not enough to provide an efficient seal. The trap was unsealed at the time of my visit, in the case of each of the above-mentioned blocks, the trap being almost dry, and choked with sand, which at the bottom was moist and foul-smelling. These traps require to be seen to, and filled with water periodically. The sewage is at present conveyed to a kind of septic tank, the effluent from which is applied to land in the Kleir Wied, to the north of the barracks. This method of disposal is quite inoffensive.

The situation of these barracks is all that could be desired. They stand on an isolated hill, some 600 feet above the sea, exposed to the fresh air on all sides, and with no insanitary dwellings near at hand. The barracks are well constructed and sanitary; with a good water supply, and a proper system of sewerage and refuse removal, the troops should be free from all epidemic disease. It has, however, unhappily been the case that there has been a good deal of sickness this past year, due to preventable causes.

At Ghain Tuffieha and Mellicha, in the extreme west of the island, are camps used by the troops, chiefly during the winter season; also at Ghain Tuffieha is the standing camp of the Mounted Infantry, the permanent strength of which averages 250 to 300 men throughout the year. The situation of each of these camps is quite satisfactory. In each case there is a good and ample supply of drinking water laid on; also a drainage system on modern principles. At Mellieha the latrines are water latrines, and the whole of the drainage is conducted to a small septic tank, the effluent from which passes into the open sea. At Ghain Tuffieha, up to the present, the dry earth system has been in use. The drains carry off drainage from cookhouse, stables, urinals, etc., to a septic tank, hermetically sealed up with great care, the effluent from which passes into the sea. When water latrines have been provided, in place of the dry earth buckets, and connected with the existing drains, this camp ought to be extremely healthy, provided the ordinary rules of camp sanitation are strictly carried out, and the drains carefully looked after.

Fort Chambray, Gozo, is an old fortress of the Knights, in which there is accommodation for (nominally) 400 troops. The barrack rooms, four on the ground floor and four on the upper floor, are 100 × 20 feet, with good windows at each end, but no openings, except a doorway, at the sides. They are therefore very difficult to ventilate. The accoutrement shelves are fixed to the walls, touching each other, and the bed-cots are very close together; but as only one company is at present in occupation there is no overcrowding. Drinking water of good quality is laid on from the public supply. Collected rainwater is pumped up regimentally for washing and flushing purposes. The drainage system is partly modern and partly old, but is now nearly all remodelled. On the whole it is satisfactory. A foul catchpit outside the married men's latrine, and a series of deeply-sunk silt traps in rear of the married quarters require certain obvious and easily practicable alterations. The latrines are on the dry earth system, with removal once a day only. Urinals are treated with lampblack and oil. These barracks are admirably situated for health, and are satisfactory in all important particulars.

Hospitals.

Valletta Military Hospital contains 232 beds, and also has quarters for 65 non-commissioned officers and men of the Royal Army Medical Corps. The buildings are ancient, and not well adapted for hospital purposes according to modern requirements. The situation is unfavourable, as, although it borders on the Grand Harbour to the east, on the west and south it is closely surrounded by crowded dwellings of the poorer class; moreover, the principal wards are deprived of the beneficial effects of the cool north-west wind by reason of the lofty houses built on higher ground in that direction. The wards are lofty, and, on account of the thickness of the walls, cool in summer and warm in winter.

The principal feature in the hospital is the famous "Long Ward," probably the longest room in the world, being 503 feet in internal length, without any break in the continuity of the ceiling or east wall. Its width is 35 feet, and its height 32½ feet. Near the middle a transept is given off to the west, of nearly equal width and height, and about 100 feet in length, forming part of the same chamber. To facilitate administration the whole apartment is divided by partitions, 10 feet high, into northern, southern, central, and western portions (20A, 20B, 20, and 20C); but from a sanitary point of view it is all one chamber. In 20A are accommodated 50 patients, chiefly Mediterranean and enteric fevers; in 20B are 60, venereal and slight cases; in 20 and 20C are slight fever cases. The cubic space is very large, 4000 cubic feet per head, reckoning the whole height of 32½ feet; if the height be taken as 12 feet, it is over 1500 cubic feet per head. These amounts appear to be ample. There are difficulties in ventilation, however, in spite of this ample cubic space, which, indeed, is of no advantage if it interferes with the free access of external, and exit of internal air. It is obviously more difficult to change the air of a room 30 feet wide than that of a room 10 feet wide, the amount of window space being the same in each case. In this instance the width is 35 feet, and the window space is not large. There are very few windows in the lower part of the walls. In the upper part there are plenty; but there is reason to believe that they have not been opened, and kept open, so freely as would have been desirable, and that consequently the ventilation of this large apartment has not been satisfactory. Notwithstanding its coolness and spaciousness, the difficulties in maintaining purity of the air, and the impossibility of isolating the patients, render this "Long Ward" an undesirable place in which to treat the sick, although at first sight to be very well adapted to the purpose. The wards on the upper floor are of moderate size and well ventilated. The flooring of the wards is of cement concrete, having a smooth impermeable surface that is easy to keep clean.

The water supply is good and ample for all purposes. The drainage system has been entirely reconstructed within the last few years, and is in accordance with modern requirements; the drains discharge into the civil sewers at three different points, being cut off by proper disconnecting arrangements. Accessible inspection chambers are provided freely. A few points of detail in construction require attention; as, *e.g.*, a proper grease trap for the cookhouse; abolition of the large foul catchpit near south-east corner of Lower Square. Other important requirements are (1) a new latrine for 20B Ward, the present one being in bad repair; (2) concreting the rough floor of latrine and urinal for No. 37 Ward.

The Families Hospital, though in rather a cramped situation, is fairly satisfactory.

The R.A.M.C. barrack room is a large apartment, 96 × 31 feet, with an annexe on one side 28 × 17½ feet; it is well lighted and airy in appearance, but on account of the great width and absence of cross ventilation it is difficult to secure a proper purity of the air.

Cottonera Hospital is a modern building of good general design, and is in an excellent, airy, and healthy situation, standing in its own grounds, at a considerable elevation. It has four large wards, 128 × 26 feet, of 32 beds each, and several smaller ones, 156 patients being accommodated in all. The wards are well designed, well lighted, and well ventilated. The ward annexes are capable of improvement. The principal sanitary defect in this hospital lies in the material of the ward floors, which are made of a soft and easily friable porous white stone; it wears away unevenly into holes, which are difficult to keep clean; the operation of ward-sweeping twice a day fills the air of the ward with fine dust, which is afterwards deposited on the patients, on their beds, and on any articles of food that may be exposed; a good deal of it must be inhaled. The floor spaces between the beds have been treated with some hardening preparation that makes the stone impermeable, but the main part of the floor in the centre has not been so treated. The provision of a smooth impermeable floor, as at Valletta, is an urgent necessity. Water supply and drainage are quite satisfactory.

Forrest Hospital (31 beds) is a hired house, not designed for a hospital, but in as satisfactory a condition as can be expected. The water supply and drainage arrangements are in good order. A considerable number of the patients (20 to 30) are treated in tents all the year round (owing to want of sufficient accommodation), which greatly adds to the difficulties of maintaining a good sanitary condition of the hospital and its accessories.

Imtarfa Hospital (42 beds) is a new building constructed in accordance with modern principles, and is in every respect satisfactory.

Citta Vecchia Sanitarium (80 beds), is an old palace of the Knights, with large airy rooms, and well fitted for treating convalescent cases; the water supply and drainage are satisfactory.

Gozo Hospital contains 15 beds, and is satisfactory in its situation and construction, water supply and drainage arrangements.

Married Quarters.

There is accommodation for about 650 married families in the Maltese garrison, and in the great majority of instances this accommodation is remarkably good. In this category are to be placed the two new blocks at Floriana, known as Misida Bastion (44 quarters), the new block in St. Francis Ravelin (6), the four new blocks at Tigne (65), D Block, St. George's (10), all St. Andrew's (36), Verdala New Block (24), Ricasoli new blocks (18), and all Imtarfa (55). These quarters are all excellent in every way, airy, and well ventilated, the water supply laid on, and good water-closets of modern wash-down pattern provided; in nearly every case also the situation is good; they are some of the most agreeable residences in the island. There are certain minor defects in sanitary detail that require attention, but nothing to interfere with their permanent usefulness, healthiness, or convenience.

The largest block of married quarters in Valletta is the building known as the Camerata, facing the Valletta Military Hospital; this accommodates 92 families, and is generally nearly full. It is an old building of six stories, and is comparable to a block of artisans' dwellings in London; being situated in the middle of the town, it is not so fresh and airy as other quarters, and some of the rooms are without direct communication with the external air; new closets of first rate pattern have been recently supplied on each floor, and the building is kept in admirably clean and good order; so that, in spite of its being somewhat crowded it is really quite a sanitary and satisfactory block of dwellings.

The other older quarters, such as those in Upper and Lower St. Elmo, Floriana Pavilion (14), St. Francis Ravelin (16), Fort Manoel, the old blocks at St George's (55), the old quarters at Ricasoli (20); St. Nicholas and Gozo (21), though not so convenient, or so well off in the way of closet accommodation and water supply, are nevertheless in a fairly good sanitary condition.

The large block of hired quarters in Strada Magazzini, Floriana, has been put into as good a condition as is practicable in regard to water supply and sanitary arrangements; but there are certain grave defects of construction in regard to the drainage (faulty pattern of W.C. liable to become untrapped, ill-ventilated closet chambers, inferior work in the underground drains) that prevent their being considered satisfactory quarters; they resemble the ordinary private houses in Valletta, etc., and are not to be compared to any of the newly erected married quarters that have been just mentioned. The hired quarters at Tigne are to be placed in the same category; those in Strada Capuccini, Floriana, are satisfactory.

There are some married quarters on the Cottonera side (Fort Salvatore (14), Vittoriosa (3), and St. Nicholas Back) that are very undesirable residences, and, indeed, hardly fit for occupation.

On the whole, the accommodation for married families is extremely good, and, from a sanitary standpoint, very satisfactory.

SECTION II.

§ 1.

The following table shows the incidence of Mediterranean Fever in the different barracks and hospitals in Malta during the nine months January to September, 1905:—

Table I.

—	Average population.	Number of cases.	Ratio per 1000.
Upper St. Elmo	392	26	66·33
Lower St. Elmo	613	84	137·03
Floriana	717	37	51·60
St. Francis	201	9	44·77
Manoel	474	29	61·18
Tigne	492	31	63·01
St. George's	1051	42	39·96
St. Andrew's (4 months)	624	15	54·00*
Verdala	618	18	29·13
Cottonera Lines	779	44	56·48
Ricasoli	639	15	23·47
Imtarfa	856	35	40·88
Various Barracks	650	28	43·08
Ghain Tuffieha Camp	473	4	8·45
Various Camps	—	14	—
Valletta Hospital	231	33	142·86
Cottonera Hospital	147	17	115·65
Various Hospitals	157	6	38·22
	9114	487	—

* Ratio calculated for nine months; the actual ratio for four months was 24·04.

The occupation of these barracks is as follows: Upper St. Elmo (old buildings), Tigne (principally huts and new buildings), and Ricasoli (old buildings), are occupied by Royal Garrison Artillery, of which there are eight companies (having an average strength of about 200 each), and a district establishment amounting to about another 200. Three companies are stationed at Tigne and outlying forts to the west; three companies at Ricasoli and outlying forts to the east; and two companies at Upper St. Elmo and St. James Cavalier. There has been little variation in the strength of the Royal Artillery during the year, which in January was about 2000, except a reduction during April to about 1800.

St. Francis is occupied by Royal Engineers, who have a total strength of about 380, many living in detached quarters; the numbers have not changed during the year.

Infantry battalions are accommodated in the old barracks of Lower St. Elmo, Floriana, and Verdala; in the new barracks of St. George's, St. Andrew's, and Imtarfa; in Manoel, which is partly an old fort and partly a hutment. Another battalion occupied until lately various old fortress barracks known collectively as the Cottonera Lines; and a detachment occupies Fort Chambray in Gozo. Several changes have occurred in the *personnel* of the infantry during the year. In January the battalions present were the Sussex, Hants, Essex, West Kent, Rifles, Dublin Fusiliers, and Rifle Brigade, each from 900 to 1000 strong; and a wing of the Yorkshire Light Infantry, 500 strong. These last and the Rifles left the island in March, and the headquarters and five companies of the Sussex left in May. In February the Lancashire Fusiliers arrived, about 700 strong, being increased by about 100 in March. During April all the battalions were reduced in strength, the Essex and Rifle Brigade losing about 150 each, the West Kent and Dublins about 100 each, the Sussex and Hants about 50 each; so that during the five months, May to September, their strength was between 800 and 900, except the Hampshires, which remained at 1000.

The Departmental Corps occupy Marsamuscetto and Old Laboratory Barracks, the various hospital quarters, and hired quarters in different parts. The total combined strength has not varied, being about 350.

Valletta and Citta Vecchia Hospitals are old buildings, Cottonera and Gozo are modern, Imtarfa is a quite new building, and Forrest is an old hired house, not built for a hospital, but now many years in occupation as such.

Ghain Tuffieha is a permanent camp for Mounted Infantry, with an average strength of 180; and also accommodates battalions under training at different times during the cold season. Pembroke is a standing musketry camp, with a floating population, and Mellieha and other camps are occupied from time to time for field training.

An examination of Table I shows that the incidence of Mediterranean Fever during the first nine months of 1905 has varied considerably in different localities. A total of 487 cases in a population of 9100 gives a general ratio, for the period, of 53·52 per 1000; this varies in different places between 8·45 at Ghain Tuffieha Camp and 142·86 at Valletta Hospital. Arranged according to the severity of prevalence, the different barracks, etc., stand as follows:—

	Attack ratio per 1000.
Valletta Hospital	143
Lower St. Elmo	137
Cottonera Hospital	116
Upper St. Elmo	66
Tigne	63
Manoel	61
Cottonera Lines	56
St. Andrew's	54
Floriana	52
St. Francis	45
Various barracks and camps	43

	Attack ratio per 1000.
Imtarfa	41
St. George's	40
Various hospitals	38
Verdala	29
Ricasoli	23
Ghain Tuffieha Camp	8

The items "Various Barracks and Hospitals," and "Cottonera Lines," including many detached forts and buildings, should be disregarded in this list, the numbers occupying any individual locality being too small to enable any safe conclusion to be drawn as to factors in causation. The following points call for explanation:—(1) the excessive prevalence of the disease in the two hospitals at Valletta and Cottonera, and in the barracks at Lower St. Elmo; (2) the relative immunity of Verdala, Ricasoli, and Ghain Tuffieha; (3) the difference in prevalence between the adjoining barracks of Lower St. Elmo (137 per 1000) and Upper St. Elmo (66 per 1000), the buildings of which are within a few yards of each other.

The next table (II) shows the relative incidence in the different barracks and hospitals month by month. It is seen (1) that Mediterranean Fever, present to a slight extent in January and February, increased in March, and again very considerably in May, the increased number of cases continuing with no diminution during the rest of the hot weather; and this in spite of the fact that the strength of the troops was decreased by about 800 in April, and again by about 600 in May. (2) It is also seen that the disease did not prevail throughout the island generally with the same degree of intensity at any one time; thus at Floriana there were nine cases in March, no other barracks showing more than three or four cases in this month; after April very few cases occurred at Floriana. In May there were 11 cases in Manoel and 17 in Lower St. Elmo; but though Lower St. Elmo continued to be severely affected throughout the summer, Manoel was practically free after June. St. George's had few cases until June, and Imtarfa few until August. There was therefore a very uneven distribution of cases, month by month, which appears to contra-indicate any one general condition, climatic or other, affecting the whole barrack population.

Table II.—Distribution of Mediterranean Fever Cases, 1905.

—	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Total.
Upper St. Elmo	—	2	4	4	4	5	4	—	3	26
Lower St. Elmo	2	—	3	6	17	19	15	10	12	84
Floriana	2	4	9	7	2	3	4	3	3	37
St. Francis	1	3	2	—	—	1	1	—	1	9
Manoel	1	—	3	4	11	7	—	1	2	29
Tigne	—	2	4	1	7	1	6	3	7	31
St. George's	1	—	1	—	5	10	5	15	5	42
St. Andrew's	—	—	—	—	—	—	3	5	7	15
Verdala	—	2	1	1	—	5	1	4	4	18
Cottonera Lines	2	4	7	3	4	5	13	4	2	44
Ricasoli	—	1	—	—	2	3	2	7	—	15
Imtarfa	1	1	1	2	2	3	1	14	10	35
Various barracks	—	—	1	2	4	2	2	6	11	28
Ghain Tuffieha Camp	—	—	—	2	—	—	—	1	1	4
Various camps	—	—	4	4	2	—	—	2	2	14
Valletta Hospital	2	—	1	2	5	6	7	6	4	33
Cottonera Hospital	—	—	—	—	6	5	1	3	2	17
Various hospitals	—	1	—	—	—	—	2	2	1	6
	12	20	41	38	71	75	67	86	77	487
Strength	10,225	10,329	9853	9471	8661	8025	7984	7881	7855	—

Table III shows the incidence of the disease amongst the different corps stationed in Malta during the first nine months of 1905.

Table III.

—	Average strength.	Number of cases.	Ratio per 1000.
Royal Garrison Artillery	1941	88	45·34
Royal Engineers	363	12	33·06
1st Lancashire Fusiliers (7 months)	815	51	62·58*
2nd Royal Sussex	642	31	48·29
2nd Hampshire	997	27	27·08
2nd Essex	951	84	88·33
1st Royal West Kent	827	37	44·78
2nd Yorkshire Light Infantry (3 months)	539	—	—†
1st King's Royal Rifles (2 months)	1043	2	1·92‡
1st Royal Dublin Fusiliers	900	41	45·56
1st Rifle Brigade	849	46	54·18
Army Service Corps	76	2	26·32
Royal Army Medical Corps	155	30	193·55
Army Ordnance Corps	80	5	62·50
Army Pay Corps	21	3	142·86
Miscellaneous	—	2	—
Cases occurring in hospital (not R.A.M.C.)	—	26§	—
	—	487	—

* The Lancashire Fusiliers arrived on February 27; the ratio is for the actual period of seven months; assuming the same rate of prevalence, the ratio would be 80·46 for nine months.

† The Yorkshire Light Infantry left in March.

‡ The King's Royal Rifles left in February; the ratio is for two months.

§ These are not included in the regimental figures, because removed from regimental conditions.

An examination of this table shows that the incidence varied considerably in the different corps. The general ratio throughout the troops has already been stated as 53·52 per 1000 for the period: arranged according to severity of prevalence, the corps stand as follows, only those present throughout the whole period being considered:—

	Attack ratio per 1000.
Royal Army Medical Corps	194
Army Pay Corps	143
Essex	88
Army Ordnance Corps	62
Rifle Brigade	54
Royal Sussex	48

	Attack ratio per 1000.
Royal Dublin Fusiliers	46
Royal Garrison Artillery	45
Royal West Kent	45
Royal Engineers	33
Hampshire	27
Army Service Corps	26

The respective numbers of the Army Service, Ordnance, and Pay Corps are so small that it would not be safe to draw any conclusions from them. The points that call for explanation are (1) the excessive prevalence of the disease amongst the R.A.M.C. and the Essex Regiment, and (2) the relative immunity of the Hampshire Regiment and the Royal Engineers.

Table IV gives the prevalence, month by month, amongst the several corps, and shows generally the same aspect of the epidemic as Table III, with which it may be compared.

§ 2.

More particular attention may now be directed to certain places where Mediterranean Fever has been especially prevalent, with a view to eliciting any circumstances that may throw light on this excessive prevalence.

Lower St. Elmo Barracks show the greatest incidence of any place, excepting the two hospitals of Valletta and Cottonera. The sanitary conditions of these barracks are shortly stated in Section I, p. 108; the water supply and drainage are in the main satisfactory, but the construction is very insanitary; the men are accommodated in casemates, 52 feet in length, with very inadequate ventilation; the situation of the barracks, which are sunk in a hollow, is also such as to render the supply of fresh air a difficulty at all times, and practically an impossibility in calm and still weather.

From the beginning of 1905 until July 8 these barracks were occupied by the 2nd Essex Regiment; on the latter date they moved to Imtarfa, and on July 11 their place was taken by the 1st Lancashire Fusiliers. This change of occupation complicates the matter, but also to some extent helps in the investigation.

The cases of Mediterranean Fever in the Essex Regiment were distributed, month by month, as follows:—

January	2	June	19
February	0	July 1 to 8	7
March	3	July 9 to 31	9
April	6	August	14
May	18	September	6

Table IV.—Regimental Incidence of Mediterranean Fever Cases, 1905.

—	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Total.
Royal Garrison Artillery	—	4	8	6	14	11	13	16	16	88
Royal Engineers	2	3	2	—	1	1	1	1	1	12
1st Lancashire Fusiliers	—	—	—	6	5	4	10	12	14	51
2nd Royal Sussex	2	4	7	2	2	4	1	4	5	31
2nd Hampshire	—	2	3	2	1	5	4	4	6	27
2nd Essex	2	—	3	6	18	19	16	14	6	84
1st Royal West Kent	1	4	8	8	2	3	4	3	4	37
2nd Yorkshire Light Infantry	—	—	—	—	—	—	—	—	—	—
1st King's Royal Rifles	1	1	—	—	—	—	—	—	—	2
1st Royal Dublin Fusiliers	1	—	1	—	4	10	5	15	5	41
1st Rifle Brigade	1	1	6	5	11	7	3	5	7	46
Army Service Corps	—	—	—	—	1	—	—	—	1	2
Royal Army Medical Corps	1	—	1	1	3	4	7	10	3	30
Army Ordnance Corps	—	—	1	1	1	—	—	—	2	5
Army Pay Corps	—	—	1	—	—	—	—	—	2	3
Miscellaneous	—	—	—	—	—	—	—	1	1	2
Hospital cases (not R.A.M.C.)	1	1	—	1	8	7	3	1	4	26
	12	20	41	38	71	75	67	86	77	487

Of these cases all, up to July 8, were admitted from Lower St. Elmo; with the exception of two in March, admitted from Pembroke Camp; and three in May, one in June, and one in July, which were admitted from Gozo. From July 9 onwards all the cases were admitted from Imtarfa Barracks, except one from Gozo and one from Ghain Tuflicha. It has been already stated that it is necessary to allow a period of 14 days for incubation in most instances, and that probably a *further period* of 14 days should be allowed in many instances, between date of contracting infection and date of admission to hospital; cases admitted more than 28 days after departure from any particular place can hardly be considered to be due to infection originating in that place. If this limit be provisionally adopted, the two cases admitted from Pembroke Camp should be referred to Lower St. Elmo, as also should three of the cases admitted from Gozo. *Per contra*, one case admitted from St. Elmo in May, 13 days after arrival from Gozo, may be debited to the latter place, though, in this instance, some doubt must be felt as to the length of the incubation period.

The 2nd Essex Regiment arrived in Malta from England, and took up quarters in Lower St. Elmo, on April 29, 1904; here six companies remained throughout the year, except for short periods at Pembroke, Mellieha, and Ghain Tufficha Camps, returning from the last-named on December 19, 1904. Two companies were stationed at Gozo (A and B) from April 29, to September 1, 1904, on which date they were relieved by D and F Companies, who remained there until May 8, 1905; being relieved in turn, on that date, by C and E Companies.

Of the total number of cases (55) occurring in the regiment between January 1 and July 8, 1905, all, except one, belonged to the six companies stationed at Lower St. Elmo; only this one came from the two companies stationed at Gozo.

The incidence of Mediterranean Fever in the different companies during the whole period of nine months, January to September, was as follows :—

A.	B.	C.	D.	E.	F.	G.	H.	Uncertain.	Total.
11	15	4	2	3	8	19	19	3	84

The companies that have been stationed throughout the whole time at Lower St. Elmo, and subsequently at Imtarfa, have been A, B, G, H; these four companies have had 64 cases; the four companies, of approximately the same strength, that have been part of the time at Gozo (C, D, E, F), have had 17 cases; of these 17, four were admitted from, and without doubt contracted the fever in, Lower St. Elmo; seven probably contracted the disease there, and four probably at Imtarfa; in two instances only, or perhaps three, was it contracted at Gozo.

It is necessary to distinguish between what is practically certain, and what is uncertain. Assuming the correctness of the diagnosis, as to which every care has been taken (as mentioned in p. 108), there is little doubt that 84 cases of Mediterranean Fever have occurred in this battalion. As to the place where infection was contracted, there is no such certainty, because the incubation period has not yet been definitely ascertained. It is a fact to be noted that 64 of these 84 cases occurred in the four companies A, B, G, H, which remained the whole time in Lower St. Elmo and Imtarfa; in three instances, two of which were from the mounted infantry at Ghain Tufficha, the company to which the man belonged is not ascertained: of the 17 cases occurring amongst the other four companies, 11 probably originated in Lower St. Elmo. There is therefore a presumption that the excessive prevalence of the fever in this battalion was due to something belonging to, or connected with, Lower St. Elmo Barracks.

These barracks consist of a range of building in three stories, the rooms in the lowest being used as stores, cookhouse, canteen, etc., and the middle and upper stories being used as barrack rooms. They were allocated thus:—

Upper Storey—
Nos. 1 to 3.—C Company, January 1 to May 6.
D Company, May 8 to July 8.
4.—Signallers.
5 to 8.—A Company all the time.
9 to 12.—E Company, January 1 to May 6.
F Company, May 8 to July 8.
13, 14.—Drums.

Middle Storey—
Nos. 1 to 4.—B Company
5 to 8.—G Company
9 to 12.—H Company
13, 14.—Band
all the time.

The actual barrack rooms from which cases were admitted are not always ascertainable with accuracy; the following particulars as to the rooms occupied are as much as I have been able to find out:—

Upper Storey.

Nos. 1 to 4.—Cases were admitted May 9, 31; June 2 (C Co.); July 31 (D Co.); total, 4 cases.

Nos. 5 to 8.—Cases admitted March 18; May 20, 21, 31; June 6, 7; July 1, 5, 11; August 4; total 10 cases (A Co.); one other case in this company lived at the sergeants' mess.

Nos. 9 to 12.—Cases admitted April 12, 22; May 1 (E Co.); July 13, 24, 28 (F Co.); total, six cases.

Nos. 13, 14.—Cases admitted May 23 (H Co.); June 10; July 2 (G Co.); total, three cases.

Middle Storey.

Nos. 1 to 4.—Cases admitted January 22; March 16; April 6; May 2, 8, 19, 31; June 2, 10, 21; July 20; total, 11 cases in B Co., of which four at least were in No. 2, and three at least in No. 3 room.

Nos. 5 to 8.—Cases admitted January 22; April 1; May 3, 26; June 8, 10, 11, 16, 21, 26, 30; July 24, 31; total, 13 cases, all in G Co., of which four at least lived in No. 8 room; two other cases in this company were drummers, living in Nos. 12 or 13, Upper Storey.

Nos. 9 to 12.—Cases admitted March 25; April 5, 18; May 3, 20, 27; June 5, 11, 17, 28; July 2, 4, 20; August 4 (two cases); total, 15 cases, all in H Co.; of these at least three were in No. 10, and three in No. 12. One other case in this company occurred in the sergeants' rooms on the Upper Storey.

Nos. 13, 14.—One case occurred, May 6; Band, F Co.

The above list accounts for 65 out of the 84 cases that occurred in the battalion. After they moved to Imtarfa on July 8, cases continued to occur, and of these 12 have been regarded as probably due to St. Elmo infection, up to August 5. After this date infection has been considered to have been contracted at Imtarfa, though very possibly introduced from St. Elmo. Three cases were admitted from G Company on August 6 and 7, which might be thought to be more likely due to a continuance of the same influence, whatever it was, that caused the special incidence on this company, with an extra long period of incubation. Eight other cases occurred up to the end of the month, and six in September, there being a very notable diminution in this month.

Before the arrival of the Essex Regiment at Imtarfa, a few cases had been admitted from the Sussex Regiment, which had been quartered in these barracks since February 22. Besides five cases in the middle of March, probably dating from Polverista, there had been at Imtarfa one case in March, two in April, two in May, two in June, and one on July 5; the disease was present, but did not prevail at the station; the average strength of the troops during January to June was 880. No cases occurred in the Sussex Regiment after July 5 until August, in which month there were four admissions from this battalion. Granting that the length of the incubation period is uncertain, if one compares the considerable prevalence of the fever at Lower St. Elmo with its trivial manifestations at Imtarfa during the early part of the summer, it appears more probable that the Essex cases occurring at Imtarfa were due to a "something" brought up with the regiment from St. Elmo than to any infection of local origin at Imtarfa. Whether this supposed infective "something" was brought up as an already ingested but latent *contagium*, within the bodies of the men who afterwards developed the disease, or whether it was introduced in fomites, or infective matters external to the body, is a question to be considered further. At this stage we are, I think, to some extent justified in the presumption that the Imtarfa cases, for at any rate four weeks and possibly longer after arrival at the new quarters, were due not to anything belonging to Imtarfa, but to some factor that had been in operation at St. Elmo, and which continued in operation for some time afterwards. The drop from 14 admissions in August to six in September is noteworthy.

It is worth while considering a converse instance; D and F Companies went from St. Elmo to Gozo on September 1, 1904, and returned to St. Elmo on May 8, 1905. From these two companies two cases of Mediterranean Fever were admitted on September 8, 1904, one on September 18 and one on October 3; the first three and perhaps the fourth case may be presumed to have become infected before leaving St. Elmo; a fifth case was admitted on October 8 (38 days after leaving St. Elmo), and not a single other case occurred during their eight months' stay at Gozo, nor (with one exception) during their stay at St. Elmo between May 8 and July 8; four cases were admitted at Imtarfa during the latter half of July. The one case admitted after return to St. Elmo that appears to have contracted the infection in Gozo (Private Lawrence, F Company) was admitted on May 21, 13 days after arrival. Whatever the conditions were that led to the prevalence amongst the occupants of Lower St. Elmo, they appear to have been absent from Gozo even more completely than from Imtarfa. The immunity enjoyed by these two companies while at Gozo continued for two months after their return to St. Elmo, yet in G and H Companies 21 cases occurred in the same two months, May 8 to July 8, 1905.

The 2nd Essex having marched up to Imtarfa on July 8, their quarters in Lower St. Elmo were taken over by the 1st Lancashire Fusiliers, who marched in on July 11. This regiment had landed in Malta from England on February 27, 1905, and on arrival were quartered in Polverista Barracks; they marched to Pembroke Camp on March 20, thence to Mellicha Camp on April 30, and returned to Polverista on May 8, remaining there until their move to Lower St. Elmo. Six companies then occupied these barracks, and two (B and D) went into Manoel Hutments.

The first admission to hospital for Mediterranean Fever occurred on April 5, that is 37 days after landing in Malta; the second admission was on April 17; until their move to St. Elmo there were 18 other admissions, that is 20 in 15 weeks; during the same period the Essex Regiment had 50 admissions; the prevalence in the Lancashires was, therefore, much less than in the Essex. During the next four weeks eight cases were admitted from Lower St. Elmo, having presumably contracted infection in Polverista. From August 9 to the end of September, 19 cases occurred in the six companies in St. Elmo, and three cases in the two companies occupying Manoel, presumably due to infection contracted in those places.

In this regiment, unlike the Essex, the incidence on different companies has varied but slightly. During the whole period from their landing until the end of September (seven months) the distribution of cases has been as follows:—

A.	B.	C.	D.	E.	F.	G.	H.	Total.
5	4	9	8	8	5	4	8	51

There is here no marked preponderance, as is the case of B, G, and H Companies of the Essex. Before the move to St. Elmo the distribution had been thus:—

A.	B.	C.	D.	E.	F.	G.	H.	Total.
2	1	2	7	2	4	1	1	20

Within the next four weeks the cases occurred thus:—

A.	B.	C.	D.	E.	F.	G.	H.	Total.
1	1	2	0	2	0	1	1	8

From August 8 until September 30 the cases occurred thus:—

A.	B.	C.	D.	E.	F.	G.	H.	Total.
2	2	5	1	4	1	2	6	23

In the first set of 20 cases D Company certainly furnishes a disproportionate number, but no common origin is apparent, and the cases were spread over three months. It may be noted that two cases in A company were admitted from the same room (No. 3 Polverista) and two cases in F Company also from one room (No. 14 Polverista). These rooms accommodate 14 men in each. The battalion was quartered in a number of small barracks, including not only Polverista itself, but also all the others making up Cottonera Lines, and was therefore widely scattered. On coming to Lower St. Elmo six companies were concentrated in one building under like conditions. It is to be noted that seven cases occurred in C Company, which occupied Nos. 5 to 8 rooms in the middle storey, the same that had just been vacated by G Company of the Essex Regiment; this company had furnished 19 cases of Mediterranean Fever, 13 of which appear to have contracted infection while occupying these four rooms, seven of these having been admitted within the preceding three weeks. Of the seven cases in the Lancashires one was a colour-sergeant who occupied the same room as a colour-sergeant of the Essex, admitted with Mediterranean Fever eight weeks before; of the other six, three cases came from No. 7 room, a room from which two cases at least had been admitted in the Essex Regiment within the preceding six weeks. Is it a mere coincidence that six men should be admitted from the same four rooms as had furnished seven cases in another regiment during the few weeks immediately preceding?

The other company that showed a relatively large number of admissions after arriving at St. Elmo was H Company; seven cases occurred between July 11 and the end of September; they were admitted from the four rooms, Nos. 10 to 13 in the upper storey; two of these came from the same room, No. 12, on September 22 and 25 respectively. These rooms had been occupied between May 8 and July 8 by F Company of the Essex Regiment, which had arrived from Gozo on May 8, and did not show any especial prevalence during its stay at St. Elmo; shortly after arriving at Imtarfa, however, three cases occurred, on July 13, 24, and 28, which had presumably contracted infection when staying in the rooms now mentioned.

With regard to the other group of cases, in C Company, the position may be stated thus: We have a body of men that have been living in Malta for rather over four months, and in that period have furnished two cases of Mediterranean Fever, apparently arising at two different places (Pembroke Camp and Corradino Prison), and with a month's interval between the two, the last admission having been six weeks since. This body of men now move into fresh quarters consisting of four rooms, just vacated by another group of persons, who have furnished 11 cases of fever during the year up to the date of leaving, seven having been admitted during the preceding three weeks. Out of the new company four are seized with the fever within six weeks. There is, I submit, a presumption that the infective agent is connected with the *place*. If this be considered a reasonable presumption, a further point to be noted is that the first admission amongst the fresh body of men occurred 20 days, and the second 22 days, after their arrival at the presumably infected barrack rooms, indicating an incubation period of about 21 days.

An examination of the incidence of Mediterranean Fever in these two bodies of men, the Essex and the Lancashires, so far indicates that the disease may prevail in a strictly localised fashion. Both these battalions have occupied old barracks with many sanitary defects; the next case to be considered is that of a battălion living in good modern barracks in a healthy situation.

§ 3.

The First Royal Dublin Fusiliers have occupied St. George's Barracks, Pembroke, since March, 1904; they arrived in Malta from South Africa in November, 1902; in February, 1903, five companies left for Crete and Cyprus, the remaining three being stationed at Imtarfa. At the beginning of March, 1904, the whole battalion came into St. George's. During 1904, only four cases of Mediterranean Fever occurred, one of which was contracted in Cyprus. Therefore, the battalion and the barracks were almost exempt from the disease during 1904. During the nine months, January to September, 1905, there have been 41 admissions. The different companies have suffered very unevenly, thus :—

A.	B.	C.	D.	E.	F.	G.	H.	Total.
13	6	5	3	8	2	3	1	41

It is seen that A Company has suffered most, with 13 cases; and H Company least, with only 1 case. In A Company there was a sequence of 5 cases between June 16 and July 6; and again a sequence of cases between August 16 and September 15; in D Company 3 cases occurred close together between August 16 and 30; and in E Company there were 3 cases between August 11 and 14, and again 3 cases between August 27 and September 10.

There is a noteworthy circumstance in connexion with the company incidence of Mediterranean Fever in this regiment: A Company, which had 13 cases, and H Company, which had only 1 case, occupy the same barrack block, lettered F; the companies are of the same strength; they each occupy seven barrack rooms; A Company having those in the eastern half, nearest the sea, and H having those in the western half. The two companies use the same cookhouse, the same ablution room, the same latrine and urinal. The barrack block is one of six single-storey buildings, and consists of 14 rooms, all alike, measuring 30 × 21 feet by 14 feet in height, and accommodating 13 men in each, with an allowance of 605 cubic feet per head. Although there are no openings in the sides of the rooms, the door and two windows at each end, and the roof ventilators, appear to provide sufficient means of entrance and exit for the free circulation of air; the rooms seem to be airy and well ventilated. There are also in each block six bunks for non-commissioned officers; these are placed back to back, with no through ventilation, and are certainly hot and stuffy; none of the fever cases in this company occupied any of these bunks; the sergeant, who was admitted on May 29, lived in A Block, Married Quarters. Though these barracks are not of the most modern type, I can find no fault with their essential sanitary conditions; the cookhouses and ablution room are excellent, the drainage system is modern, and, with trifling exceptions, of good construction; the drains are kept in excellent order, and the sanitation of the lines carefully attended to. The one important sanitary defect is the scarcity of water for flushing purposes, leading to a foul state of the water latrines of occasional, or perhaps frequent, occurrence. As regards situation, nothing better could be desired; they form a complete contrast to Lower St. Elmo and Floriana Barracks, and the extremely objectionable places occupied by troops in Cottonera Lines. They are freely exposed to the air on all sides, with no habitations near, and in three directions are practically open to the sea. Complaint was made by some men occupying No. 14 room (the one nearest to the sea) of bad smells coming from the sewer outlet into the sea in this direction. With the existing scarcity of water for flushing purposes, no doubt the drain air is occasionally offensive and the sewage malodorous; but I do not think that any harm could result to the occupants of these barracks therefrom; the outlet is many hundred yards distant from any of the buildings.

There does not appear to be any condition affecting A Company that does not equally affect H Company, and as the latter has been immune to Mediterranean Fever throughout 1904 and 1905, to the end of September (with the exception of one case), the cause for the prevalence in A Company is not obvious. The drinking-water supply and the milk supply are common to the whole regiment; the milk has been boiled, not by companies separately, but by the master cook centrally for all; therefore, whether effectually sterilised or not it has been consumed in the same—boiled or unboiled—condition by all companies alike.

In these barracks, as in most of the older barracks in the island, it has been the practice to affix the accoutrement shelves to the walls of the rooms in a continuous line, and not to separate them from each other as far as the linear space will allow. It is the custom to arrange the bed-cots in symmetrical order, each under the shelf that holds the occupant's kit and accoutrements. The length of the shelf is 3 feet 5 inches, the width of the bed is 2 feet 5 inches; consequently, when the shelves and beds are so arranged, there is only a space of 12 inches between bed and bed. Although the occupants have each 605 cubic feet of air space in the room, they are not evenly distributed so as to get each one his fair share, his one-thirteenth part, of the total cubic space; but they are crowded together, with only a foot between each pair of beds. Now, whatever the *materies morbi* may be, if it be once introduced into a room arranged like this, infection from person to person will the more readily take place, the closer the men are crowded together. So that if we assume that there is a particulate *contagium*, capable of being conveyed from an infected to a non-infected person, such an arrangement as now described would facilitate spread of the disease, when the *contagium* has been once introduced, or has been introduced in sufficient quantity. But until it has been introduced, the arrangement would have no effect. In the case of these barracks, in which the sanitary conditions are uniform and (except for aggregation of beds and scarcity of flushing water) satisfactory, this aggregation offers a plausible explanation of the *spread* of the fever, though not of its origin.

§ 4.

There are eight companies of Royal Garrison Artillery quartered in Malta, their total average strength for the first nine months of 1905 amounting, with the District Staff, to 1941 : in this body of troops there occurred 88 cases of Mediterranean Fever (besides seven cases contracted in hospital), giving a ratio of 45·34 per 1000. There was, however, considerable variation in the prevalence in the different companies, as shown in the following table:—

Royal Garrison Artillery.

	Strength.	Cases.	Attack ratio per 1000.
No. 1 Company.........	190	13	68·4
5 ,, ...	235	8	34·0
63 ,, ...	216	4	18·5
65 ,, ...	205	17	82·9
96 ,, ...	217	15	69·1
99 ,, ...	222	12	54·0
100 ,, ...	240	10	41·7
102 ,, ...	215	7	32·5
District Staff	196	2	10·2

The men of the Garrison Artillery in Malta are, as a rule, older and of greater length of service, than the average infantry soldier: a larger proportion also have already had foreign service. As to length of stay in the island, two of these companies (63 and 99) arrived in 1902, two (99 and 100) in 1903, and the other four in 1904; it is not unusual, however, for men to exchange from one company to another, and under present arrangements the companies do not move from station to station *as a body*, but change their *personnel* by individual reliefs. The two companies that have been longest in Malta show a great difference in their fever incidence, No. 63 having had 18·5 cases per 1000, and No. 96 having had 69·1 cases per 1000; Nos. 99 and 100 arrived together, and show a similar incidence, 49·5 and 41·7 per 1000; Nos. 1, 5 and 65 arrived together, but show an incidence very unequal, viz., 68·4, 34·0 and 82·9 per 1000: No. 102, which arrived three months earlier, only 32·5 per 1000. It does not appear that length of residence in Malta can account for the great variation in this year's prevalence of the fever in the Artillery.

The variation, however, has a relation to the barracks in which the different companies have been quartered. Two companies have been stationed at St. Elmo, three companies at Tigne (with a detachment at St. George's for a part of the time), and three companies at Ricasoli; thus:—

Upper St. Elmo—		
No. 65	17 cases	82·9 per 1000
96	15 ,,	69·1 ,,
Tigne—		
No. 1	13 ,,	68·4 ,,
99	12 ,,	54·0 ,,
102	7 ,,	32·5 ,,
Ricasoli—		
No. 5	8 ,,	34·0 ,,
63	4 ,,	18·5 ,,
100	10 ,,	41·7 ,,
St. James Cavalier, etc.—		
District Staff	2 ,,	10·2 ,,

A portion of 65th Company has been accommodated in St. James Cavalier and Castille, but only one case of fever has occurred among the men of this detachment. All companies have from time to time sent detachments to the outlying forts and practice camps; two cases have occurred in such detachments from 65th Company, and one from 96th Company. If these be deducted from the St. Elmo figures the incidence on the troops stationed there will be lessened, but the disproportion between the different barracks will not be diminished; for out of the 10 cases in 100th Company, no less than five were apparently infected at outlying forts; and of the seven cases in 102nd Company two were similarly of outside origin. The numbers are too small to justify any important deduction, but it is certainly noteworthy that the companies quartered in Valletta have been much more severely affected than those at Ricasoli, those at Tigne occupying an intermediate place.

The barracks at Upper St. Elmo are not quite satisfactory, but are not nearly so bad as Lower St. Elmo, or St. James Cavalier; the chief points are—defective latrine and urinal arrangements, and the continual use of tents, which must lead to fouling of the ground. St. James Cavalier is a very bad barrack, overcrowded and impossible to ventilate, with insanitary latrine conditions owing to scarcity of water: Mediterranean Fever has not however been prevalent there. On the other hand the sanitary condition of Fort Ricasoli is, on the whole, satisfactory, except that the large barrack rooms are difficult to ventilate: the situation of this fort is ideal; as is that of Tigne barracks, which last are in as good a state, sanitarily, as Ricasoli: the incidence of Mediterranean Fever has however been greater at Tigne. I am not able to trace any definite connexion between the degree of prevalence of Mediterranean Fever amongst the different artillery units and the respective sanitary conditions of the barracks in which the units were quartered.

The isolation of Ricasoli from all native surroundings is fairly complete: this may be said in a lesser degree of Tigne: but from Tigne the men habitually go to spend their spare time in Valletta, whereas from Ricasoli it is not, I am informed, at all common for the men to cross the Grand Harbour to spend their evenings in the town. Isolation (habitual though not complete) does not however prevent the occurrence of the disease, as 11 cases have occurred amongst men stationed in outlying forts and camps, the disease having apparently been contracted in these places. Though situated in the open country, and generally near the sea, so as to be airy and healthy, there are certain insanitary conditions present in nearly all these forts. From the necessity of the case the sleeping rooms are imperfectly ventilated, though I did not find that there had been any overcrowding anywhere, except at Benghisa. In most forts the water supply was scanty, leading to parsimony in its use for latrine and urinal flushing, where water latrines are provided. Dry earth latrines are, however, in general use; and, with some few exceptions, are kept in an insanitary condition. With a scanty water supply, a very imperfect method of removal of excreta, and a minimum amount of air space, or air change, in the sleeping rooms, the forts cannot be called sanitarily satisfactory; but as regards the general health of the men quartered in them, it appears to be excellent, in spite of these sanitary shortcomings. Two cases were admitted from Fort Delimara on the same day (August 10), and two cases from Ta Silch within a week of each other (September 6 and 13); in no other instance was there any apparent connexion between cases at any of the forts.

Three cases were admitted on three successive days, May 18, 19, 20, in No. 65 Company, from tents at Upper St. Elmo, but I was unable to ascertain if they had occupied the same tent. Two cases occurred out of eight occupants of the same room, No. 6 Lower Storey, in 96th Company, on March 23 and April 19. Two cases occurred in 99th Company in the same hut, No. 6; and two other cases also in the same hut, No. 8, at Tigne, within a fortnight of each other in September; there were 16 occupants in each hut. Within the space of 14 days in August three men were admitted from No. 1 barrack room, Ricasoli, in 5th Company, accommodating 33 men; and two men, out of five occupying a room at the Auberge de Castille, and employed at the Royal Artillery officers' mess, were admitted on

June 9 and July 29. What connexion there may have been between these cases is doubtful. No. 1 room at Ricasoli is especially difficult to ventilate; the room at the officers' mess is reported to be close and stuffy; the Upper St. Elmo rooms and the Tigne huts are sanitarily satisfactory.

§ 5.

There are two infantry battalions that have not suffered to any great extent from Mediterranean Fever during 1905, but which offer a contrast, the one to the other. The 1st Royal West Kent Regiment arrived in Malta on April 15, 1904, and after a month in camp at Pembroke and Mellieha were quartered in Floriana Barracks, where they have remained ever since, except for a month in camp in November and December, 1904, and again three weeks in March, 1905. One company however, B, was in camp at Ghain Tuffieha for three months from February 1 to May 1. During the nine months 37 cases of Mediterranean Fever were admitted from the battalion, the distribution by companies being as follows:—

A.	B.	C.	D.	E.	F.	G.	H.	Uncertain.	Total.
6	1	4	1	5	3	7	8	2	37

The barracks occupied by this regiment are of a composite character. Three companies have been quartered in the "Old Barracks," which are casemates of the type so common in Malta; these are especially difficult to ventilate, on account of their great length, which is about 80 feet; they have however not been overcrowded, as the battalion has not been up to full strength, and the cubic space has therefore been nominally sufficient; instead of 30 men, not more than 24 have generally occupied one room. It is however evident that an apartment 80 feet in length, with no lateral openings whatever, cannot possibly be supplied with a proper change of air by natural ventilation. Three companies have been quartered in the New Barracks, which consist of three separate two-storey blocks, constructed with every regard to the principles of modern sanitation; each room accommodates 26 men. One company has been quartered in Notre Dame Ravelin Barracks, a single storey building consisting of 16 small rooms, with five men in each; and one company has been divided between one room in the Old Barracks and two huts in the Ravelin; the band also occupy huts in the Ravelin; each hut accommodates 18 men. A small detached fortress, the Salvatore counterguard, accommodates a party of signallers, numbering 30.

The number accommodated in the Old Barracks is 360, in the New Blocks 318, in the Ravelin and Salvatore 245; total, 923. The distribution of cases of Mediterranean Fever has been thus:—

A, C, and G (Old Barracks)	17 cases.
B, E, and F (New Barracks)	9 ,,
D (Ravelin)	1 ,,
H (Old Barracks and Ravelin)	8 ,,
Uncertain	2 ,,
	37 ,,

Three companies occupying the Old Barracks have had 17 cases; three occupying the New have had nine cases; one company occupying the Ravelin has had one case, and H Company, divided between the Old Barracks and Ravelin, has had eight cases. One case, however, in A Company was admitted, not from Old Barracks but from Notre Dame Ravelin (a bandsman); the one case in B Company, and one case in E, occupied huts in Ravelin, not the New Blocks; and one case in H was infected apparently in Pembroke Camp, not in the Old Barracks. Making these corrections it is seen that the admissions were as follows:—

From Old Barracks, accommodating 360	23
From New Barracks, accommodating 318	7
From N.D. Ravelin, &c., accommodating 245	4
From Pembroke Camp (1), Ghain Tuffieha (1)	2
Uncertain	1
	37

It seems evident that the incidence on the body of men occupying the Old Barracks is disproportionate, although the numbers are too small to afford much ground for drawing any decided conclusion. In two instances there seems to have been a likely connexion between cases; in A Company two admissions took place from No. 8 room, one on March 28, the other on April 10; in H Company three men were admitted from No. 3 room, on April 2, 9, and 24; the exact room that a man slept in is not ascertainable in every instance, although it is generally possible to localise the part of the barracks occupied with some accuracy. It is quite clear that the battalion, as a whole, did not suffer uniformly, but that there was a prevalence amongst some groups of men, or in some portions of the barracks.

§ 6.

The 2nd Hampshire Regiment has furnished fewer cases of Mediterranean Fever during the period under consideration than any other regimental group: there have been 27 cases in a strength of 997 men. They arrived in Malta on September 16, 1903, and have remained in

Verdala Barracks all the time, with short yearly absences in camp. A portion of the battalion has occupied some of the smaller barracks in Cottonera Lines (Polverista, St. Clement's, etc.), but no especial difference is observable in the incidence of the fever upon these different detachments, the ratio for the whole battalion being 27 per 1000, and for the Verdala portion 29·1 per 1000. The cases occurred sparsely throughout the year, not more than six occurring in any one month (September), and no company contributing more than four; in only one instance has there appeared to be any connexion between one case and another: a man was admitted from Zabbar Gate on July 6, and another from the same place on July 15.

The general sanitary condition and surroundings of Verdala and the Cottonera Lines are certainly not better than those of Floriana, and in one important respect, that of scanty water supply for flushing purposes, they have been much worse off; the small casemate rooms in Verdala are, however, much better ventilated than the large casemates in Old Floriana Barracks.

The 2nd Royal Sussex Regiment arrived in Malta from England on June 27, 1904, and were quartered in Polverista and other barracks in the Cottonera Lines. They were in camp at Pembroke and Mellieha, four companies at a time, for a month in November and December; and the whole battalion together at Ghain Tuffieha for a fortnight in January, 1905. They marched up to Imtarfa on February 22 and 26, and on May 29 five companies, with the headquarters, left for Crete. During 1904 they suffered little from Mediterranean Fever, having had only 11 admissions altogether; up to the departure of the five companies to Crete at the end of May, there had been 17 admissions during 1905; these cases had been scattered about in different companies and barracks, and there was no particular incidence on any one company or barrack. Between June 26 and August 24 there were five admissions from C Company, all from the same barrack block (H), and two from the same room (No. 97), on August 4 and 10; from this room also another man was admitted on September 21. H Company occupies the other half of H block, from which four other cases were admitted between April and September, but no two from the same room. The rooms vary in size, some accommodating 16, and some 20 men; No. 97 accommodates 20 men.

§ 7.—*Hospitals.*

The total number of cases of Mediterranean Fever that apparently contracted the disease in hospital, either as patients admitted for some other illness and subsequently developing this fever under circumstances pointing to hospital infection, or as non-commissioned officers and men of the Royal Army Medical Corps, and other men attached for nursing duties, amounted to 56. Of this number 33 occurred at Valletta Hospital, 17 at Cottonera. The accompanying table shows the distribution in detail. It is seen that, in all, 23 patients in hospital contracted the disease, 30 R.A.M.C., and three men attached for nursing duties :—

——	Average number of patients.	Average number R.A.M.C.	Cases of Mediterranean Fever.		
			Patients.	R.A.M.C.	Men attached.
Valletta	157	74	11	19	3
Cottonera	102	45	10	7	—
Forrest	47	10	1	2	—
Citta Vecchia...	47	15	1	2	—
Imtarfa	25	8	—	—	—
Gozo	2	3	—	—	—
	380	155	23	30	3

The total average hospital population, including patients and orderlies, amounted to 535, amongst whom there occurred 56 cases of Mediterranean Fever, being in a ratio of 104·66 per 1000. Of these, 23 occurred in an average population of 380 patients, being in a ratio of 60·53 per 1000; and 30 in an average population of 155 orderlies R.A.M.C., or, 193·55 per 1000. While the incidence is decidedly greater on the men of the R.A.M.C., this varies in the different hospitals; thus at Valletta the ratio among the patients was 70·1, among the R.A.M.C. 256·8 per 1000; at Cottonera, among the patients 98·0, among the R.A.M.C. 155·6 per 1000. The incidence upon the patients is not, however, fairly comparable either with that upon the R.A.M.C., or with that upon any of the regimental units that have been previously considered; because the hospital *sick population* is constantly changing. The R.A.M.C. prevalence can be fairly compared with that of any other unit, and the severity of the outbreak amongst this body of men is immediately evident. The highest ratio in any regimental unit is that of the Essex Regiment, 88·33 per 1000: and for any barracks, that of Lower St. Elmo, 137·03 per 1000; for the R.A.M.C. as a whole the ratio is 193·5, for those quartered in Valletta Hospital 256·8, for those at Cottonera Hospital 155·6 per 1000.

The incidence upon the patients at Valletta Hospital, 70·1 per 1000 was less than that upon the Essex Regiment; at Cottonera the patients suffered more, viz., 98·0 per 1000; but these ratios are not properly comparable, as just mentioned.

The circumstances that lead to the opinion that the infection was contracted in hospital in the following instances will now be shortly stated, beginning with the sick under treatment for other forms of illness :—

Case 1.—Private Minter, Essex Regiment, was admitted from Lower St. Elmo to Valletta Hospital on February 14, with "gonorrhœa"; on March 25 he was transferred to Forrest Hospital; his "disease" was changed to Mediterranean Fever on April 20; it is almost certain that infection was contracted in one or the other hospital, more probably in Valletta than in Forrest.

Case 2.—Private Salmon, Rifle Brigade, was admitted to Valletta Hospital for "debility" from Manoel Hutments, on March 24, 1905. He was treated in 20 A Ward. He was transferred to Citta Vecchia Sanatorium, April 17; and discharged to duty at Manoel, May 1. He was again admitted to Valletta on May 14, having been ill for about 10 days. His illness commenced in the first week of May, and was contracted either in Valletta or Citta Vecchia Hospitals, most probably in the former.

Case 3.—Gunner Jardine, R.G.A., was admitted to Valletta Hospital from Upper St. Elmo suffering from "orchitis" on April 3; he was transferred to Citta Vecchia on May 22, and the "disease" changed to Mediterranean Fever on June 1; his infection was almost undoubtedly contracted in Valletta Hospital.

Case 4.—Gunner Moore, R.G.A., was admitted to Valletta Hospital from Upper St. Elmo with "gonorrhœa" on April 7; his "disease" was changed to Mediterranean Fever on June 13, after more than two months' stay in hospital, during which time he must have taken the infection.

Case 5.—Private Bush, Essex Regiment, was admitted from Lower St. Elmo to Valletta, suffering from venereal disease, on May 24; on June 6 he was transferred to Cottonera, and on June 26 began to be ill with Mediterranean Fever; the infection was probably contracted within the preceding 33 days, *i.e.*, after his admission to Valletta Hospital; but it is uncertain whether at Valletta or Cottonera; moreover, Mediterranean Fever was prevalent at Lower St. Elmo in May. This is a doubtful case of hospital infection.

Case 6.—Private Potter, Rifle Brigade, was in Valletta Hospital with venereal disease from May 16 to June 7, when he was discharged to St. Andrew's Barracks. He was admitted to Forrest Hospital on June 29, suffering from Mediterranean Fever, having been ill for about one week before this; it is more probable that he took infection in Valletta Hospital before June 7, than in St. Andrew's Barracks between June 7 and 22; these barracks had just been completed and taken into occupation on June 2.

Case 7.—Private Gerard, Rifle Brigade, was admitted to Valletta from Ghain Tuffieha Camp on May 14, suffering from gonorrhœa; on July 1 Mediterranean Fever was diagnosed; infection was almost certainly contracted during the preceding six weeks in hospital.

Case 8.—Private Wilding, Rifle Brigade, was admitted to Valletta, 20 A Ward, from Manoel on May 30, with enteric fever; on July 16 he was found to be suffering from Mediterranean Fever and the "disease" was changed; infection was probably contracted during the preceding 46 days in hospital; unless it be supposed that a double infection had been contracted originally, and that the enteric symptoms and agglutination phenomena had masked those of Mediterranean Fever.

Case 9.—Gunner Marjerum, R.G.A., was admitted to Valletta on July 29, with Mediterranean Fever, having only been discharged from the same hospital 10 days before, during three or four of which he was sickening with the fever; he had previously been under treatment in 20 B for six weeks (gonorrhœa), and in this period probably contracted the infection.

Case 10.—Private Heaton, Lancashire Fusiliers, was admitted to Valletta from Lower St. Elmo on August 1, with Mediterranean Fever, having already been ill a few days. From June 28 to July 15 he had been in the same hospital, treated for "debility," but without any symptoms of Mediterranean Fever. It is more probable that infection was taken during the fortnight before than during the fortnight after, July 15; but the case is an uncertain one. The battalion had moved from Cottonera Lines to Lower St. Elmo on July 11; several cases of fever had occurred, but not in this man's company, about that time.

Case 11.—Private Keylock, Hants Regiment, was admitted to Valletta Hospital with gonorrhœa on July 29; he was discharged on September 1, and readmitted, suffering from Mediterranean Fever, on September 15. It is almost certain that he contracted the infection during his stay in hospital.

Case 12.—Private Collins, Hants Regiment, admitted to Cottonera March 23, 1905, suffering from enteric fever, as shown by serum reaction; serum reaction was negative to Mediterranean Fever, March 27 and April 29, but positive on May 1, when he had been in hospital 38 days; infection was therefore probably contracted in hospital, though conceivably along with the enteric infection before admission.

Case 13.—Private Bishop, Hants Regiment, admitted from Verdala to Cottonera, March 30, with scarlet fever; was isolated in No. 12 Ward from this date until April 26, when he was transferred to No. 5 Ward, where he remained until discharge on May 2; was readmitted May 10, and diagnosis made of Mediterranean Fever on May 15. His illness came on suddenly on May 9, and was almost certainly contracted between March 30 and May 2, while he was in Cottonera Hospital.

Case 14.—Gunner Abbott, 65th Company, Royal Garrison Artillery, was admitted from Upper St. Elmo to Cottonera, May 16, and placed under observation for mental disease. After being in hospital under close observation for 30 days symptoms of Mediterranean Fever developed, and the diagnosis was made on June 21. The length of sojourn in hospital before onset of fever symptoms points to infection contracted within the hospital precincts. It is to be noted, however, that three men in 65th Company were admitted with Mediterranean Fever on May 18, 19, and 20 (having presumably been ill a few days before, and conceivably infectious); and that other admissions from the same company for this disease took place on June 1, 3, 16, 19, and 20; infection was therefore present in this company in Upper St. Elmo.

Case 15.—Private Haines, Hants Regiment, was admitted from Verdala to Cottonera, No. 10 Ward, with "abscess," on April 21; Mediterranean Fever was diagnosed May 19; there were fever cases in No. 10 Ward at the time of his admission; it is more probable that infection was taken during the 29 days' sojourn in this ward than in Verdala Barracks previous to admission; in these barracks one case only had occurred in March, one in April, and none in May.

Case 16.—Gunner Duncan, 63rd Company, R.G.A., was admitted from Ricasoli to Cottonera, No. 1 Ward, with gonorrhœa, on April 4; on May 22 Mediterranean Fever was diagnosed. This was almost certainly contracted during his preceding seven weeks' sojourn in hospital. Only one case of fever occurred at Ricasoli (February 3) during the first four months of the year.

Case 17.—Private Knight, Hants Regiment, was admitted from Couvre Porte to Cottonera, No. 1 Ward, on March 28, with gonorrhœa. Mediterranean Fever was diagnosed on May 23, seven weeks afterwards. Infection was almost certainly contracted in hospital.

Case 18.—Private Wilkinson, Lancs. Fusiliers, was admitted from Zeitun Barracks to Cottonera, No. 1 Ward, with gonorrhœa on March 3: the first symptom of fever was felt about June 3, and the diagnosis made on June 13. Infection certainly contracted in hospital.

Case 19.—Private Shortland, Hants Regiment, was under treatment in Cottonera Hospital for gonorrhœa from April 26 to June 3. On June 20 he fell ill, and was admitted on 21st, suffering from fever, which was diagnosed on 29th. The shortest incubation period may probably be considered to be about 14 days; he might have contracted infection, therefore, in the three or four days immediately after his discharge from Cottonera on June 3; or while in hospital during the previous fortnight. Four cases were admitted from Verdala Barracks in June, one being from the same company as Shortland; there had been no admissions in May; during this month and the early part of June, when he presumably contracted infection, there were 20 or more cases of Mediterranean Fever in Cottonera Hospital, which was therefore a more likely source of infection than Verdala Barracks.

Case 20.—Gunner Taylor, 99th Company, R.G.A., was under observation for mental disease in Cottonera Hospital from June 2 to 20; he was readmitted with fever on June 29, and Mediterranean Fever was diagnosed July 7. It is more likely that infection was contracted between June 2 and 20, than between June 20 and 29; or before June 2.

During July and August no cases of Mediterranean Fever appear to have arisen among the patients at Cottonera, though four orderlies of the R.A.M.C. were attacked.

Case 21.—Private Smith, Royal West Kent Regiment, was in the hospital from June 27 to July 5, and from July 7 to August 5, suffering from wound of foot: during the latter period he was in No. 1 Ward. He was readmitted with gonorrhœa on August 11. He first felt ill with fever on September 3, and Mediterranean Fever was diagnosed on September 9. He might have contracted the infection during his brief residence in Floriana Old Barracks between August 5 and 11; or in hospital during the 24 days immediately preceding the onset of his illness, when he was in No. 1 Ward, in which were Mediterranean Fever patients. Floriana Old Barracks suffered from fever earlier in the year, but no case was admitted from them between July 24 and August 28.

Case 22.—Private Palmer, Essex Regiment, was transferred from Valletta to Citta Vecchia Sanatorium on December 19, 1904, suffering from hernia; on February 2, 1905, his "disease" was changed to Mediterranean Fever; the date of onset is not certain, but the probabilities are that infection was contracted in hospital, either at Citta Vecchia or Valletta.

Case 23.—Gunner Haynes was admitted to Forrest Hospital from Tigne on May 12, with enteritis, and was transferred to Citta Vecchia on August 16; on September 1 his "disease" was changed to Mediterranean Fever; the blood had reacted before leaving Forrest, and infection was, without doubt, contracted there.

Of the above 23 cases it may be affirmed that 16 almost certainly became infected in hospital; Cases 5, 6, 10, 14, 19, 20, and 21 are doubtful: but in my opinion the probabilities are much in favour of hospital infection in all the cases except No. 5 (Bush), 10 (Heaton), and 14 (Abbott), in which the uncertainties are considerable. Of the 11 Valletta cases, eight were venereal patients treated in 20 B Ward; Salmon and Wilding had been inmates of 20 A Ward; in the case of

Heaton, who had been under treatment for debility, the ward is uncertain. Of the 10 Cottonera cases, four venereals and one other (Smith) had been treated in No. 1 Ward, two (Abbott and Taylor) had been in observation wards, two (Collis and Haines) in the "fever wards," and one (Bishop) in No. 5 Ward. Therefore, 10 out of the 11 Valletta cases had been inmates of the same apartment (albeit a very large one) as was occupied by patients suffering from Mediterranean Fever: and 3 out of the 10 Cottonera cases had, in the same way, been treated in the wards along with the Mediterranean ·Fever patients.

Of the 19 cases amongst N.C.O.'s and men of the R.A.M.C. at Valletta Hospital, the following were brought into intimate association with the Mediterranean Fever patients, being employed in the fever wards, either as nursing, or as general duty, orderlies: Elsey, Brooks, Smith (14,901), Bowden, McGill, Smith (19,123), McConaghey, Whitmore, Aldous, Hardless, Playle: 11 in all. The following were not employed in these wards, and did not come into any continued or close association with the fever patients. Q.M.S. Dudman, Brown (clerk), Farr (cook), Sergeant Dewberry (laboratory), Corporal Hughes (day wardmaster, not in fever wards), Corporal Woods (pay office), Robinson (P.M.O.'s clerk), Q.M.S. Bridges: eight in all. Of these eight men it may be said that not only were they not brought into any special contact with fever patients, but that they had absolutely nothing to do with them, either directly, or indirectly (except the two quartermaster-sergeants). These two non-commissioned officers had certain duties in regard to the clothing and bedding of the patients that would constitute an indirect connexion. Sergeant Dewberry was specially employed as assistant in the laboratory of the Mediterranean Fever Commission; there can be little doubt that it was in this occupation that he contracted the disease.

All the corporals and privates of the R.A.M.C. sleep in the same barrack room, No. 31 (with an adjacent bunk); this is a large apartment, 96 feet long by 31 feet wide, the side annexe being 28 × 17½ feet. The room is well lighted, and airy in appearance, but on account of its extreme width and the absence of through cross ventilation (the annexe and two sergeants' rooms adjoining it on one side), it is difficult to secure a satisfactory change and renewal of the contained air. The height is 20 feet in the main room, and 15 feet in the annexe. The accommodation is authorised as for 54, giving an average cubic space of 1238 cubic feet per head; or, reckoning the height at 12 feet, of 770 cubic feet per head. The room has been full throughout the year, but not overcrowded in the hot weather, as many of the men sleep out on the roof, or on the verandah. The three men attached to R.A.M.C. for duty also slept here. Of these, two (Davis and Franklyn) were employed in the female hospital in general duty work. Cases of

Mediterranean Fever have been under treatment in this hospital throughout the year, but the orderlies were not brought into direct association with them in any way.

Of the seven cases occurring amongst R.A.M.C. at Cottonera Hospital, five were employed in the Mediterranean Fever wards; the other two, Rogers and Miller, were both employed in the hospital kitchen; part of their duties being to supervise the milking of the goats; they also took their turn of general night duty.

The two cases of R.A.M.C. at Citta Vecchia had both been employed in attendance on convalescent Mediterranean Fever patients, of whom there have been a large number at this hospital throughout the greater part of the year.

At Valletta Hospital four ladies of Queen Alexandra's Imperial Military Nursing Service have been employed in nursing duties. Of these, one has suffered from Mediterranean Fever during the past year. At Cottonera there is also a staff of four, and during 1904 and 1905 six nursing sisters have been attacked; four cases occurred in June and July, 1904, and two in January, 1905. At the Military Families Hospital, which is situated alongside of the military hospital, Valletta, the head nurse was placed on the sick list with Mediterranean Fever on June 20, 1905. All these ladies have been engaged in attendance on patients suffering from the disease, and have, therefore, been brought into intimate contact with them. At Valletta the sisters live in the hospital quadrangle. At Cottonera there are sisters' quarters in a detached house in the hospital grounds. It has been the practice until July, 1905, to milk the goats that provide milk for the patients on a plot of ground within a few yards of these quarters; and there is no doubt that this area was extensively fouled every day for a long period. No cases have occurred amongst the sisters at Cottonera during the summer, since the goats were removed from this spot.

§ 8.—*Women and Children.*

During the period under review there have been, as far as I have been able to ascertain, 38 cases of Mediterranean Fever amongst the families of the troops, 27 of which have been women, and 11 children. The exact number of the population from which these cases were derived is not yet available; but probably varied little from that of the preceding year, when there were 567 women and 928 children present in Malta (belonging to the garrison) on an average. The cases occurred all over the island, and there was no particular prevalence in any one group of quarters.

Allusion may be made in this place to the very remarkable prevalence of Mediterranean Fever in the New Misida Married Quarters in 1904. These quarters accommodate 44 families; A Block was completed and taken into use in 1903, B Block in 1904. A study of the cases shows that there were 12 cases in 44 families, of which nine at least occurred in the 24 families occupying A Block. Twelve of these quarters are on the ground floor, and 12 on the upper floor; one of the cases occurred in No. 3 on the ground floor, and eight cases occurred in the 11 quarters on the upper floor. All the adjoining quarters were affected, from Nos. 14 to 19 at the north-east end of the block; Nos. 20 to 24 were unaffected, and in B Block to the south-west, there were two cases only amongst 20 families. It is uncertain whether Sergeant Biltcliffe lived in A or in B Block.

During the year 1904 there were, according to the Annual Sick Return, 109 cases of Mediterranean Fever amongst the women and children of the garrison. I have only been able to trace records of 67 of these, viz., 42 women and 25 children; the remainder were probably treated in quarters, and as to the diagnosis, I am unable to offer any opinion. Without attempting any statistical statement as to the prevalence in the various married quarters, it is certainly the case that nowhere else was there such an alarming incidence as in this particular block of buildings.

There are not many instances in which more than one member of the same family has been attacked. The following are all that I have been able to ascertain as occurring during 1904 and 1905. In the Misida quarters, Floriana, Mrs. Sanders was taken ill in July, 1904, and Colour-Sergeant Sanders was admitted on August 30; Sergeant Rogers was admitted September 21, and Mrs. Rogers on December 13; Mrs. Westbrook was placed on the sick list on October 2, 1904, and a child on January 23, 1905, the mother having a relapse a few weeks later.

At the Camerata married quarters (where about 90 families are in occupation) only one instance has occurred lately: Staff-Sergeant Lowe was taken ill in September, 1904 (presumably infected in hospital), and Mrs. Lowe in October. At St. Francis Ravelin Corporal Sullivan was admitted on July 13, and his child fell ill very shortly after. Two children in the family of Sergeant Hammett were attacked in 1904, one in June, the other in October. At Valletta Hospital, the wife of Quartermaster-Sergeant Bridges was admitted on May 27, 1905, the child on July 28, and Sergeant Bridges himself on August 11. Quartermaster-Sergeant Dudman was admitted on January 8th, 1905, and Mrs. Dudman on July 17. Conductor Fasson and Mrs. Fasson, living at Sliema, were placed on sick list on April 23 and May 9 respectively. The wife of Captain Challoner, living at Sliema, was first taken ill in November, 1903; the illness continued until May, 1904; on July 1 her son sickened, and a fortnight later her daughter. The wife of Major Preston, also living at Sliema, was attacked in the middle of January, 1905; her sister, and an English maid, were both taken ill about four weeks later; Gunner Hardy, a soldier servant living in the house, was admitted to hospital on April 18.

In some of these cases some common condition was most probably the cause of the attack in both man and wife, or parent and child; but where an interval of several weeks elapses between the attacks, the likelihood of direct infection must be borne in mind. But as pointed out by Dr. Johnstone in his Report of last year (p. 38), if direct infection were always an important factor in the spread, it would be expected that a large proportion of multiple attacks in families would occur, and this has not been the case.

SECTION III.

From the foregoing account of the mode of prevalence, or behaviour, of the Mediterranean Fever epidemic during the first nine months of 1905, it may now be possible to gather some outstanding facts that will help either (1) to indicate the mode, or modes, of spread of the infection; or, if this is not evident, or probable, then (2) the conditions that assist in the spread of the disease may be ascertained, or shown to be probable.

§ 1.

It has been shown (1) that Mediterranean Fever has appeared in all the barracks in the islands, in which are quartered any considerable body of men (say one hundred or more).

(2) Although the disease has been universal throughout the garrison, the barracks have been affected very unevenly, Lower St. Elmo having had an attack ratio of 137 and Ricasoli of only 23 per 1000. The highest incidence has occurred in Valletta Hospital, 143 per 1000; Lower St. Elmo, 137 per 1000; Cottonera Hospital, 116 per 1000. These three places have suffered far more than any others, Upper St. Elmo having only had 66 admissions per 1000, and all the other barracks being less affected (mostly between 40 and 60), until at the bottom of the list come Verdala (27), Ricasoli (23), and Ghain Tuffieha Camp (8 per 1000).

(3) All the different bodies of troops have suffered, except such small parties as the Military Foot Police (numbering 16), and the Mounted Infantry Staff (numbering 11); and one battalion of over 500 strength, but which left the island in March (K.O. Yorkshire Light Infantry).

(4) The variation in prevalence has been equally well marked in the case of different bodies of men, as in the case of different barracks. The Royal Army Medical Corps suffered to the extent of 193 per 1000; the Hampshire Regiment had only 26 admissions per 1000. After the R.A.M.C. the Essex Regiment suffered most, 88 per 1000; four other infantry battalions and the Royal Artillery had between 43 and 54,

while the Royal Engineers had only 33, and the Hampshire Regiment only 26 per 1000.

(5) Although the total number of admissions for Mediterranean Fever increased in March, and again very markedly in May, remaining with little variation at a high level throughout the rest of the summer, this was not the case uniformly throughout the island; the maximum prevalence differing in different barracks; *e.g.*, in Lower St. Elmo it was in June, at St. George's in August, and at Cottonera in July.

(6) On examining more closely into the prevalence of the disease in different regiments it is found that there is a considerable unevenness of incidence on different groups, *i.e.*, companies, occupying the same barracks, and living under apparently almost identical conditions. For instance, in the Essex Regiment, G and H Companies had each 19 cases; of these 38 cases, 21 occurred between May 8 and July 8; alongside of them, and living under the same conditions in every way, were D and F Companies; no case at all occurred in D, and only one in F Company, during this period. The difference (or, *a* difference) between the two bodies was, that G and H had been living in Lower St. Elmo all the year, while D and F had been at Gozo until May 8. Again, from the four barrack rooms in the middle storey, Nos. 9 to 12, there were admitted 16 cases up to the departure of the regiment on July 8; from rooms Nos. 9 to 12 on the upper storey, accommodating the same number of men (about 90), there were admitted in the same period only six cases; in the former case the rooms were occupied throughout the whole time by H Company; in the latter the rooms were occupied by E Company up to May 6, who then went to Gozo, their place being taken by F Company, from Gozo. Sixty-four cases have occurred in the four companies that have been all the time at Lower St. Elmo and Imtarfa, 17 cases in the other four companies that have been part of the time at Gozo, as well as at St. Elmo and Imtarfa. The great prevalence in the Essex Regiment appears to be connected with residence in Lower St. Elmo barracks, and especially with certain rooms in those barracks.

(7) The Lancashire Fusiliers took the place of the Essex in Lower St. Elmo on July 11; after this date seven cases occurred in C Company, which occupied the rooms vacated by G Company of the Essex, the company that had suffered severely in the earlier part of the year. In H Company of the Lancashires, seven cases occurred after arrival at St. Elmo; they occupied the same rooms as F Company of the Essex, a company which had arrived from Gozo in May, and had suffered little; but shortly after their arrival at Imtarfa they had three cases (presumably contracted while living in these rooms at St. Elmo); local infection seems not unlikely. The other companies of the Lancashires suffered little.

(8) The Dublin Fusiliers have occupied St. George's Barracks since

March, 1904; all the companies are living under precisely similar conditions; out of 41 admissions for Mediterranean Fever during the nine months, A Company has had 13 and H Company has had only one: these two companies live in the same barrack block, use the same cookhouse, latrine, urinal, and ablution rooms; they are of the same strength; yet one has had 13 cases, the other only one.

(9) The eight different companies of the Royal Artillery have suffered very unevenly; No. 65 Company has had 83 per 1000 admissions, No. 63 company only 18·5 per 1000. The two companies stationed at Upper St. Elmo have had many more cases in proportion than the three companies at Ricasoli; Upper St. Elmo has had a greater incidence than any other barrack except the adjoining Lower St. Elmo; Ricasoli has had the lowest incidence of any barrack.

(10) The Royal West Kent Regiment, occupying Floriana barracks, have not suffered severely; they furnish another example of an uneven, and limited, prevalence; of 35 total admissions the origin of one is uncertain; as to the remaining 34, the *Old* Barracks (accommodating 360) contributed 23, the remaining 11 coming from the *New* Barracks, Ravelin, etc. (accommodating 563).

(11) The ratio of incidence on Hospital populations, reckoning patients and attendants together, is high, 104·7 per 1000, but not so high as among the troops at Lower St. Elmo (137 per 1000); at Valletta Hospital, however, it is 143 per 1000, Cottonera showing 116 per 1000, and the smaller hospitals much less. The attendants, taking all the hospitals together, suffer much more (193·5 per 1000) than the patients (60·5 per 1000); but the incidence upon the patients is not fairly comparable, as they are a very fluctuating population. Taking the two large hospitals, the incidence upon the orderlies of the R.A.M.C. is 257 per 1000 at Valletta, and 156 per 1000 at Cottonera, both figures being considerably higher than in any other body of troops.

(12) There has been no great prevalence of Mediterranean Fever amongst the married families during the period under consideration, though cases have occurred everywhere throughout the married quarters. In comparatively few instances have two or more members of a family been attacked under circumstances indicating direct infection from one to the other. There has been no recurrence of the remarkable outbreak of 1904 in one particular set of newly-built married quarters (Misida Bastion), which seemed to point so strongly to some strictly localised condition.

§ 2.

We may now consider what information can be obtained from the foregoing account of Mediterranean Fever prevalence in 1905, as to its probable mode of spread. Infected water, infected food, infected air, are the three most obvious possible channels of conveyance; these may be first dealt with.

i. *Infected Water.*—The water supply of Malta has been sufficiently described in Dr. Johnstone's Report. So far as concerns the military population, there are no barracks in which there is not an ample supply of drinking water of good quality (known as No. 1 Water), in every case laid on direct from the main, and therefore free from any danger of local contamination. The same water is supplied to all the barracks. It is inconceivable that with such a supply, and such a method of distribution, there should be a prevalence characterised by the special features that have been above noted, if the drinking water were the channel of conveyance. Although it is the case that another quality of water is also supplied for ablution purposes, which is not so pure, and which therefore might be thought to be a carrier of infection, this is in the highest degree improbable. Everywhere the taps supplying this water are marked, "Not for drinking," and everywhere the pure supply is quite as readily obtainable as this ablution water. Careless as the soldier may be about his health, he is not such a fool as to drink water marked "unfit," when there is a tap of good water alongside; such a case might occur very exceptionally, but not as a common practice. Moreover, in barracks that are supplied *only* with No. 1 water, such as St. Andrew's and Tigne, and in married quarters, such as the new Misida blocks at Floriana, Mediterranean Fever has prevailed more extensively than in some other places, such as Verdala and Imtarfa, which have a double supply. As was pointed out by Hughes, if the inferior water supply were the channel of conveyance, "we should expect the inhabitants of private houses in the same area supplied only with the good water to be immune from [Mediterranean] fever; but this is very far from being the case."

The use of *ice*, and of *aërated waters*, is really to be considered along with the question of water supply. During the summer months the use of ice is universal amongst those that can afford it; few people in comparison drink plain water; nearly everyone drinks aërated water and ice; if any particular parcel of ice were infected there could hardly fail to be an explosive outburst of the fever, analogous to a water epidemic. There is no evidence to this effect, and no suspicion seems ever to have been excited that such was the cause. So with lemonade, soda water, and other aërated drinks that are consumed by everyone in the hot weather, there appears to be no evidence whatever incriminating these articles.

§ 3.

ii. *Infected Food.*—The two articles of food that appear to be the most likely channels are *milk* and *uncooked vegetables.* With regard to the latter, I regret that I have no evidence whatever: the methods of cultivation in vogue in Malta would lead one to look upon all uncooked vegetables as dangerous articles of food. Human excrement is largely used as manure, and one would regard lettuces, tomatoes, radishes, and all vegetables eaten in the way of salad—*i.e.*, uncooked, also certain fruits, such as strawberries, with great suspicion. There is a fairly general consumption of such articles by the people who can afford to buy them; but by the troops they are hardly eaten at all. It is a failing of the British soldier that has been frequently commented on, that he does not take advantage of the vegetable food that is available, wholesome, nourishing, and cheap, in the different parts of the world in which he serves. He has no culinary instinct, he cannot dress vegetables, and he cannot make a salad. Such things do not form part of the men's ordinary food, nor, as far as I have been able to ascertain, are they an article of consumption in the regimental coffee shops and supper bars, or in the eating-houses frequented outside barracks.

§4.

The question of the conveyance of *milk* is one of great importance, on account of the discoveries recently made as to the existence of Mediterranean Fever in goats, and the presence of *Micrococcus melitensis* in milk of apparently quite good quality, and yielded by goats in apparently perfect health.

The facts bearing upon this question now to be related fall under three heads: (1) The conditions as to milk supply of the different bodies of troops in Malta: (2) the conditions as to milk supply of the married families, and the prevalence of Malta Fever amongst them; (3) evidence as to milk consumption by Malta Fever patients.

(1) *Conditions of Milk Supply amongst the Troops.*

The procedure adopted in the different regiments has been as follows:—

Royal Garrison Artillery—Upper St. Elmo: 65th and 96th Companies. —Only condensed milk is used; no goats at all come into the fort, except one or two for the married people occupying the two married quarters.

Tigne: 1st, 99th, and 102nd Companies.—All milk used by the troops is tinned milk, except at the sergeants' mess, where it seems that a small quantity of goats' milk has been used.

Ricasoli: 5th, 63rd, and 100th Companies.—All milk used by the troops is condensed milk; one or two goats come into the fort for the married families.

Outlying Forts.—Only condensed milk is used.

This custom of using condensed milk is, in Malta, almost peculiar to the Garrison Artillery; it is probably due to the fact that a great number of the men have had considerable service in India, where the milk is, speaking generally, of obviously poor quality from a housekeeper's point of view, and lies under a very widely-held suspicion of impurity from the medical standpoint, chiefly in regard to enteric fever. This is now a matter of general knowledge amongst the troops in India. Condensed milk is now of such good quality, and so cheap, that the Artillery and their families use it, almost without exception, and are well satisfied with it. In the outlying forts, where the arrangements and supervision are less complete, goats' milk may be occasionally used; but I think it must be of rare occurrence, because amongst the Artillery the feeling is, and for a long time has been, decidedly in favour of condensed milk; the kinds used are Milkmaid brand and Nestlé's.

The *Lancashire Fusiliers* have used goats' milk. Since arrival at Lower St. Elmo on July 11 no goats have been allowed inside the fort, except one or two for married families. The goats have been milked outside, morning and afternoon, the milk brought to the regimental cookhouse and immediately boiled, under the supervision of the master cook.

The *Royal Sussex* Regiment at Imtarfa use only condensed milk.

The *Hampshire* Regiment (at Verdala) use goats' milk; the goats are milked outside the barracks; the milk is brought to the cookhouse and boiled.

The *Essex* Regiment use goats' milk. When at Lower St. Elmo no goats were allowed inside the fort, except one or two for the married families. The goats were milked outside, the milk brought into the regimental cookhouse, and boiled under the supervision of the master cook. The same arrangement is carried out at Imtarfa.

The *West Kent* Regiment at Floriana use goats' milk. The goats are milked outside the barrack gate. The milk is then taken to the various cookhouses (Old Barracks, Notre Dame, New Barracks), but it has not been boiled during the greater part of the summer.

The *Dublin Fusiliers* at St. George's use goats' milk. The goats are brought to the skittle-alley in the lines, and milked under the supervision of the master cook, who is then responsible that the milk is boiled in one of the company cookhouses. It is all boiled together. The skittle-alley is cleaned out daily.

The *Rifle Brigade* at St. Andrew's use goats' milk. The goats all come to one cookhouse, and are milked under the eye of the master cook, who then sees that the milk is boiled. One or two goats are sent up to the married quarters.

At *Valletta Hospital* the goats are milked under supervision in the paved back entrance to the lower square. The milk is "Pasteurised" in an Aymard steriliser.

At *Cottonera Hospital* the goats are milked under supervision in a specially selected place. The milk is "Pasteurised" in an Aymard steriliser.

At Forrest, Imtarfa, Citta Vecchia, and Gozo Hospitals the milk is boiled.

The rule has been to boil, or Pasteurise, all milk throughout the garrison, with the exception of the West Kent Regiment and the Royal Artillery; the last named have used only condensed milk. As regards hospitals, this rule has been in operation for the whole of 1905 and most part of 1904. As regards troops, it is difficult to state exactly when the boiling commenced. Until recently, it was looked on as an advisable proceeding, but perhaps hardly worth the trouble, and was probably carried out somewhat perfunctorily. But, from the beginning of July, 1905, there can be very little doubt that, with the exceptions mentioned, all milk consumed by the troops in barracks has been definitely boiled, that is, "brought to the boil." Horrocks has shown that an exposure for 10 minutes to 68° C. (154° F.) is sufficient to destroy *Micrococcus melitensis*, naturally present in goat's milk (*i.e.*, the milk of a goat that is suffering from the fever and excreting the organism in its milk). Therefore, even supposing some laxity in the carrying out of the boiling regulations, the milk supply of the troops (with the exceptions noted) must be regarded as having been rendered harmless. So much attention was drawn to the question of the milk supply (consequent on the discovery of the presence in the milk of *Micrococcus melitensis*) during June, 1905, and the early part of July and the admissions for fever were so numerous throughout the garrison, that I feel no doubt that the boiling was carried out effectively, and not perfunctorily, from this time onward.

No diminution in the number of admissions occurred in August or September, when the full effect of this precaution would have become evident; on the contrary, the admissions increased from 67 in July to 86 in August, and in September numbered 77. The regiment that did not boil its milk (the Royal West Kent at Floriana) had an admission rate for the nine months of 43·53 per 1000, being the lowest but three of any corps in the island.

It may have been that men were infected by milk consumed outside barracks. This cannot be denied, but it is highly improbable. It is very rarely that the British soldier drinks milk at any time, and the refreshment of which he partakes during his hours of relaxation outside barracks is almost invariably of an entirely different description.

(2) *Conditions of Milk Supply among Married Families.*

A house-to-house visitation was made throughout the various married quarters, and particulars were obtained of the people's habits in this matter; the results of which are summarised in the following paragraph. The figures refer to 1904 and 1905. I am aware that statements made in answer to questions of this kind have to be taken *cum grano*, but I feel confident that the actual state of things was ascertained in the great majority of cases, practically in nearly every case. Moreover, no instance has been put down as positive, *i.e.*, no use of condensed milk only, or of condensed and boiled milk only, has been returned as such, unless there was good reason to believe that this was really the case: any case of the least doubt has been returned under the heading of "unboiled, more or less."

Out of the 322 families thus inquired into, embracing a total population of 1213, it is seen that 441 persons consumed only condensed milk, and among these 14 cases of Mediterranean Fever occurred, giving a ratio of 31·74 per 1000. Amongst 398 persons, who drank either condensed or boiled milk, but never unboiled milk, 13 cases occurred, giving a ratio of 32·66 per 1000, which is practically identical with the first-mentioned. Taking these two categories together, we have a population of 839, with 27 cases, *i.e.*, a ratio of 32·18 per 1000. The remainder, 374 persons, who drank unboiled milk either habitually or occasionally, furnished 24 cases, *i.e.*, in an attack ratio of 64·17 per 1000, or exactly twice the incidence of the protected population. Taking all the men together, 10 cases occurred among 322, or 31·05 per 1000. All the women, 322, had 21 cases; all the children, 569, had 20 cases. The ratio for the whole population (51 cases among 1213 persons) is 42·04 per 1000. The women suffered the most, 65·21 per 1000; the men the least, 31·05 per 1000; the children very slightly more than the men, 35·14 per 1000.

If, for the sake of argument, we leave the men out of the question (for the importance of milk as a factor in causation is likely to be much less in their case than in the case of women or children), and deal only with the remaining population of 891, we find that 277 persons drinking unboiled milk furnished 21 cases (75·81 per 1000), while 614 persons drinking only boiled or condensed milk furnished 20 cases (32·57 per 1000).

If we consider the children only, as being those most likely to be affected, we find that 180 drinking unboiled milk furnished 13 cases (72·23 per 1000), while 389 drinking boiled or condensed milk furnished seven cases (17·99 per 1000), that is, the former suffered just four times as much as the latter.

The numbers are too small to prove anything, but there is, in my opinion, a considerable presumption that, in the cases occurring amongst women and children, the disease was introduced by infective goats' milk. It is to be noted that a disproportionate number of cases occurred in the Floriana married quarters (17 cases in 63 families, with a population of 230; three other women and one other man were attacked, but their milk supply is not known). As stated elsewhere

(Section II, § 8) there is reason to believe that some special cause was in operation in these quarters in 1904. Looking at the prevalence of the disease amongst the families as a whole, in spite of all the variations in the surroundings of the quarters, in their structure and sanitary fittings, the character of the milk supply appears to have an important, and in the case of children, a dominant influence.

(3) Particulars have been obtained in regard to 155 cases of Mediterranean Fever that have occurred amongst the troops in 1905, as to their consumption of milk before being taken ill. What the men usually say is, that they "drink no milk at all"; on further questioning this resolves itself into "no milk except in tea."

In 13 cases it was definitely acknowledged that unboiled milk had been drunk, in greater or less quantity, as a beverage; in nine cases that it had been taken in tea only. In these 22 cases infection by milk is a quite possible explanation of the causation of the disease.

In 26 cases it was definitely stated that no milk *at all* had been drunk, not even in tea; or if any had been taken in tea, that it was condensed milk; and in 17 cases it was stated with equal definiteness that, although milk had been taken in tea, it was known to be boiled. In these 43 cases infection by milk must be regarded as in the highest degree improbable.

Three men stated that they had consumed a considerable quantity of milk, but that it had always been boiled, or "sterilised." These three were cases that had arisen in Valletta Hospital, where an Aymard's steriliser has been in use for two years, and the statements may be taken as correct.

The remaining 87 cases stated that they drank no milk at all except in tea; whether or no it had been boiled they were not aware. It is the universal custom in barracks to add milk to the tea in the cookhouse, before distribution; individuals, therefore, would not know whether it had been boiled or not. The practice of boiling the milk became general at the beginning of July, 1905:* any men admitted after the end of this month, if their milk consumption was confined to the regulation tea, are not likely to have drunk any milk other than what had been boiled. This applies to 34 cases. To these must be added seven cases in the Artillery (who use no goats' milk at all). Deducting (34 + 7 =) 41 from the 87 cases, there are left 46 cases, as to whom it may be said that infection by milk cannot be excluded.

It is seen that, out of the 155 cases, milk infection is quite possible in 22, and is not unlikely, or at any rate not to be excluded, in

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* The West Kent Regiment did not boil their milk until later; only three of these cases belong to this regiment, and they were admitted before June; the *omission* of the precaution did not apparently bring about any cases in this regiment during July and later, any more than its *adoption* prevented their occurrence in the other regiments.

46: while it is unlikely in 41, and in the highest degree improbable in (43 + 3 =) 46. I regret that I have been unable to interview every one of the 487 cases that have occurred during the period under review. All the cases that I was able to get access to I did examine, with the result just stated. I have no reason to doubt that they present a fair sample of the whole; but the account is, of course, not a complete one, referring only to about one-third of the cases that occurred. If trustworthy information could be obtained as to 500 cases, the question might be settled. As it is, I consider that while the evidence as regards married families, and especially children, is fairly strong in favour of the transmission by milk, as regards the troops it is negative. It would not be justifiable to affirm that the circumstances of the milk supply of the troops, considered in relation to the fever prevalence, in any way invalidate the theory of milk-transmission; but I do not find anything in these circumstances, as they existed during 1905, to lead one to suppose that milk can have had any important part, or indeed any part at all, in disseminating the specific poison during this epidemic *amongst the troops*. The experimental evidence obtained by the laboratory investigations of the Commission during the past year have been so conclusive as to the infectivity of goats' milk in Malta, that no want of proof from the epidemiological side can weaken its force; all that can be said is that milk does not explain the incidence of the disease upon the troops during this particular period. That a body of men such as the Royal Artillery, numbering about 2000, should have had 88 cases (45 per 1000), although practically they drink no goats' milk at all; that of these men some companies (such as those at Upper St. Elmo) should have had an attack rate as high as 66 per 1000; while the general attack rate has been 53, in one regiment only 27, and in a regiment that habitually partook of unboiled milk not more than 45 per 1000 (exactly the same as in the Artillery who drank none at all)—this indicates that milk infection has not been an important mode of propagation among the troops.

A rational explanation of this lies in the fact that, as already mentioned, milk enters but very slightly indeed into the dietary of the British soldier. Occasionally and exceptionally the reverse is the case; and it is not at all unlikely that the men who have been in the habit of drinking milk (as a beverage or food, not merely in tea, etc.), have suffered largely. There are, however, no statistical data in existence as to the frequency or rarity of milk-drinking amongst soldiers. It is impossible, therefore, to say whether or no these milk-drinkers have suffered disproportionately in Malta.

§ 5.

iii. *Infected Air.*—Recent researches have shown (1) that *Micrococcus melitensis* is discharged in the urine of Mediterranean Fever patients, being frequently present in enormous numbers; (2) that it is able to survive in a dry state for long periods when not exposed to the direct rays of the sun; (3) though it has not been demonstrated in the fæces of patients, Eyre has found it in the fæces of artificially infected guinea-pigs. There is, therefore, good ground for supposing that air containing excretally contaminated dust may bring about transmission of the disease. Such air may be "sewer air," or "latrine air," or "urinal air," or (in Malta) the air of houses, streets, roads, and fields throughout the islands.

(*a*) The well known observations of Carnelley and Haldane, Parry Laws and Andrewes, Petri, and others, have shown that the air of sewers, which are regularly and properly flushed and ventilated, is remarkably free from micro-organisms of any kind; moreover, those that are present are derived from the external air rather than from the contents of the sewer. When fermentative or putrefactive processes occur, however, with formation of gas bubbles, there is a likelihood, as Frankland has pointed out, that sewage microbes may be disseminated in the air. Tichborne considered that they might be carried about, as on a raft, by condensed vapour formed during the cold hours of the night, and dissipated when the air becomes warmed, leaving the imponderable microbe floating in the air. There is such a large body of evidence connecting outbreaks of infectious disease with the breathing of air contaminated with sewer emanations that some such explanation is required; notwithstanding the observed paucity of micro-organisms (and *a fortiori* of pathogenic organisms) in the extensive experiments that have been carried out, the connexion between disease outbreaks and the breathing of sewer air, or excretally contaminated air, has also been a matter of such frequent observation that the possibility of transmission of disease in this way cannot be disregarded. It is known that bacteria cannot be given off from a surface that is kept constantly moist; from a surface that is alternately moist and dry, however, they would be likely to be dislodged by various causes, such as concussion, strong currents of air, or even in the course of drying. The sewerage system of Malta has up to the present suffered from a very insufficient supply of flushing water; and there is no doubt that, to a very great extent, the sewer walls have been alternately wetted and dried, and therefore in a condition to render the disengagement of sewage organisms, including the various pathogenic bacteria present in the excreta of infected persons, not only possible but likely. Amongst these pathogenic bacteria *Micrococcus melitensis* must be considered to be potentially present for a great part of the year.

In regard to barracks this inadequacy of drain flushing has also existed to a greater or less extent. At Upper and Lower St. Elmo, Floriana, St. Francis, Manoel, Tigne, and Ricasoli the amount of flushing water has been on the whole sufficient, and the condition of the drains satisfactory; that is to say, they have been self-cleansing, and their walls have been free from deposit. At St. James' Cavalier, Verdala, throughout the Cottonera Lines, and at St. George's, Pembroke, the flushing water has been, as a general rule, throughout the first nine months of 1905, scanty; it is probably correct to say that it has been insufficient for the proper cleansing of the drains. At Imtarfa it has been somewhat scanty, and at Gozo. St. Andrew's has only been taken into occupation during the summer of 1905; so far there has been a sufficient supply of flushing water. There has been no scarcity of flushing water for the drains at any of the hospitals. Throughout all these barracks the drainage systems are, on the whole, of modern type, well laid, well ventilated, and well trapped; only once did I find any serious obstruction. There are however numerous defects of detail in construction or maintenance which require attention (as specified in a separate report), and which, unless attended to, will in course of time lead to dangerous conditions in the barrack drainage systems. As especially bearing on the point now under consideration—escape of sewer air—may be mentioned the following:—(1) The unsealing of W.C. traps in several married quarters in Strada Magazzini, Floriana (owing to the quarters being vacant and the closets disused). (2) The unsealing of gulley traps outside Married Quarters at Imtarfa, owing to no water being used for washing the verandahs (to receive which these traps were provided), and to long-continued dry weather. (3) Direct communication with a drain at the side of the road within a few yards of the back gateway of Verdala Barracks, an inlet acting as an outlet, and the drain being imperfectly ventilated, so that a bad drain smell is perceptible on a much-frequented roadway. (4) There has been persistent complaint on the part of the occupants of the Old Block of Married Quarters in St. Francis Ravelin, as to bad smells coming from the ventilating shafts of the Civil Government sewer, the nearest of which shafts is some 300 or 400 yards distant; alterations have been made from time to time, some shafts have been closed, and one has been carried to a greater height; the nuisance, however, still continues. (5) At Couvre Porte there is a ventilating shaft for the Civil Government sewer, opening over the roof of the barrack, and 42 feet above it; bad smells are complained of, especially at night.

The above five instances of escape of sewer air into, or in the neighbourhood of, barracks and quarters are the only definite cases that came under my notice in making my enquiries as to the sanitary condition of barracks in Malta. In the first instance, at the Strada Magazzini Married Quarters, Floriana, at the time of my visit a stoppage had occurred in the main drain of the block of quarters; I was informed that this was not an uncommon occurrence: as two branch drains at least enter the main drain at right angles, instead of in the direction of the flow, a stoppage is not unlikely to occur from time to time; but I understand that on this occasion the actual obstruction was lower down, near to, or at, the junction with the street sewer. Such inspection pits as are provided are cemented down, so that the condition of the drain cannot be seen to and precautions taken to prevent a stoppage; consequently it may exist for a day or two, or more, before being discovered; meanwhile the foul air is laid on to the quarters, in which are situated the untrapped W.C.'s, and from them escapes into the small backyard, whence it gains access to the quarters above, whose windows open into this yard. Bad smells were particularly complained of by the occupants of No. 12 (Barrack Warden Budden) and No. 13 (Corporal Bellfield, Royal West Kent Regiment). Mr. Budden had an attack of Mediterranean Fever in June, 1905, his two children suffer from sore throat, not severely, but chronically. Corporal Bellfield's family have not suffered from any fever or throat affection. The wife of Corporal West (Royal West Kent Regiment), who occupied No. 6 quarter (in which is one of the faulty W.C.'s) the year before, was admitted for Mediterranean Fever in June, 1904. The occurrence of these two cases of the disease in connexion with the faulty sanitary condition is to be noted; but no other cases have occurred in these quarters, nor have I been able to trace any connexion between the occurrence of Mediterranean Fever and the other instances of sewer air nuisance just mentioned. It is true that six cases have occurred during 1903–5 in the Old Block of Married Quarters, St. Francis Ravelin, which have been thought to be due to effluvia escaping from the civil sewer ventilator, some 300 or 400 yards distant. This, however, does not appear to be probable. Two cases were admitted from Couvre Porte in 1904, and one in 1905. This does not indicate any particular infective property in the emanations from the sewer ventilator above the roof of this barrack, undesirable as they undoubtedly are. Several cases of illness—often fatal—occurred during the summer amongst the children occupying the Married Quarters at Imtarfa, where drain air escaped through unsealed traps on to the verandah; but none of these were Mediterranean Fever.

The theory of infection by sewer air of course presupposes that there has been previous passage of the specific *contagium* into the sewer in question. There is little difficulty in believing that this is the case in regard to the public sewers of Valletta, etc.; but in the specific instances mentioned of drain emanations in barracks the same cannot be said; there were but few cases of the disease at Verdala and Imtarfa, therefore little active contagion passing into the drains; and it would be making too large an assumption altogether to put down these cases to drain infection. In fact, the barracks where the flushing of the drains was most inadequate, such as Verdala, Cottonera Lines, and St. George's (in which therefore the drain air would be most dangerous) have not suffered the most severely; while the barracks that have suffered most (Upper and Lower St. Elmo, Tigne, and the two large hospitals) are those which, whatever their other sanitary shortcomings, have at any rate had no lack of water for flushing, no troubles with regard to their drainage arrangements, and certainly no defects leading to sewer emanations in the barracks.

The effect of breathing emanations from the public sewers in Valletta, etc., would be more likely to be evident in those who live in the crowded parts of this city, or of the other thickly populated places across the Grand Harbour. A plausible explanation would be thereby afforded of the high incidence on Upper and Lower St. Elmo, neither of which barracks can be approached without passing along crowded streets, whose inhabitants (mostly, though not all, of the poorer class) have little regard for any kind of sanitation, and are content that their closets and drains should be habitually foul and pestiferous. Verdala is however in almost equally bad case in this respect, yet it has suffered very slightly.

(*b*) *Latrine Air.*—The condition of the latrines in the different barracks in Malta is, in many cases, extremely unsatisfactory, the cause generally being an inadequate water supply. The type of latrine in general use is the "Jennings' continuous pipe latrine," which is a good pattern and, when properly used, quite free from offence. The dry earth system is still in use in some barracks. At Lower St. Elmo new water-closets were fitted up in the early part of 1905, with improved siphonic flushing arrangements; although these arrangements are susceptible of further improvement the latrines, both upstairs and downstairs, have been kept in a sanitary condition without difficulty, and the water supply has been ample throughout the year.

At St. Andrew's Barracks, only recently completed, the latrines are new, and of good pattern, and the water supply has been so far ample. At Fort Ricasoli, and at Valletta, Cottonera, Forrest, Imtarfa, Citta Vecchia and Gozo hospitals, the water supply has been sufficient, and the latrines kept in good order.

Throughout the rest of the barracks the latrines have not, speaking generally, been kept in a satisfactory condition. In the various barracks that make up the Cottonera Lines the supply of water for flushing has habitually been inadequate; indeed, it has often been altogether cut off, so that the latrine pans have been allowed to become partially dry, excreta remaining in the pans and fouling the sides, and in this way gradually drying up and becoming scattered about as dust; this occurred at Polverista, St. Paul's Bastion, Vittoriosa, and elsewhere. At Upper St. Elmo, St. James' Cavalier, Floriana Old Barracks, and Verdala, the water supply has been scanty, and the flushing not done often enough; consequently, the latrines have habitually, or frequently, been over-full; in which case, when they are emptied, there is a likelihood of excreta remaining on the sides of the latrine to a greater or less extent, and eventually becoming dried and disseminated as dust. At Tigne a new latrine has quite recently been opened; at present it is in good order and quite clean. Tigne (until July, 1905), Manoel, Pembroke Fort, Imtarfa, Gozo, and all the outlying forts and encampments (except Fort Rinella and Camp Mellieha) have had the dry-earth system of removal; the removal is effected once only in the 24 hours, very early in the morning, about 3.0 or 4.0 A.M. As the greatest use of the latrines takes place between 8.0 and 10.0 A.M., it follows that the excreta are retained in the lines for from 16 to 18 hours every day instead of being removed at the earliest possible moment. If the application of the dry earth were immediate and thorough, this retention of foul matter might perhaps be harmless, or even inoffensive. As a matter of fact, it is very seldom the case that the system is properly carried out, and the net result is that dry-earth latrines are generally in a filthy and insanitary condition, for, at any rate, many hours of the day and night. All the latrines on this system in Malta (with very few exceptions) have been habitually in a foul state. Fort Rinella and Camp Mellieha have a water system of removal, with a good supply of water. Fort Ta Silch has had a dry-earth latrine for night use (which has also been habitually used during the day), and a temporary trench system just outside the fort; this arrangement has been very unsatisfactory.

The only barracks that can be considered to have been free from the effluvia of fæcal matter are those first mentioned, viz., Lower St. Elmo, Ricasoli, and St. Andrew's; also Fort Rinella and Camp Mellieha; in all the others persons using the latrines have, during a great part of the day, been subject to whatever risks may be considered to arise from breathing air contaminated with fæcal emanations, that is, effluvia from excreta in a more or less fresh condition. All the hospitals have been free from this risk. The case, as regards Mediterranean Fever in these barracks, is that the occupants of Lower St. Elmo have suffered more than those of any other barrack, and the occupants of St. Andrew's to about an equal extent with those of most of the barracks (see Table I); Ricasoli has suffered but slightly. The hospital population has suffered considerably, but this can hardly have been on account of the state of the latrines, which have been maintained in a satisfactory condition throughout the island.

In the two barracks that have suffered least, although in Ricasoli the latrine air has been free from fæcal emanations, in Verdala the reverse has been the case: while of two barracks, lying alongside of each other, and similar in situation and general construction, St. Andrew's, with quite new latrines well flushed, has suffered more than St. George's, with scantily-flushed latrines, many of which have been in existence for a long time, and have therefore become proportionately foul.

There does not appear, therefore, to be any definite evidence connecting the incidence of Mediterranean Fever with the presence of fæcal emanations, as far as concerns the troops, during the period under review.

As regards married families, the principal Married Quarters—Camerata, Tigue, Old and New Floriana, New Verdala, St. Nicholas, Ricasoli, and St. Andrew's—are provided with water-closets of excellent pattern, and are quite free from any kind of drain or latrine emanations. This cannot be said of the older quarters, such as St. Nicholas Back, and the old St. George's blocks, where latrines of old pattern are still in use; nor of the hired quarters in Strada Magazzini, Floriana, which have been already alluded to. Although a few cases have occurred in the latter quarters, most of the women and children attacked have lived in the newer quarters (such as New Floriana), which are provided with water-closet chambers and fittings of the best and most modern kind. Such cases cannot be regarded as due to infection through "fæcal emanations."

(*c*) *Urinal Air.*—The recent researches as to the viability of *Micrococcus melitensis* in dust, and the demonstration that Mediterranean Fever can be communicated to goats (though not, so far, to monkeys) by feeding them on dust infected with the urine of Mediterranean Fever patients, make it necessary to examine into the condition of barracks in regard to the presence or absence of urinary contamination of the air. Throughout the island the barrack urinals are constructed on the same general plan, viz., ranges of partitioned stalls made of slate, flushed with water from a sparge pipe, the flow being carried direct into the nearest drain. It has been for some years the custom to cover the slate surface with tar from time to time, a result of which has been that the surfaces have generally become rough and uneven, leading to collections of urinary sediment all over the lower part. The water flushing has also been quite inadequate to keep the stalls clean; this has been partly due to an insufficient quantity of water being used, and partly to its being inefficiently applied, the holes of the sparge pipes being very generally blocked up, or the pipes themselves being fixed in a wrong position. The consequence has been that barrack urinals have generally been dirty and ill-smelling. During the past year a new arrangement has been brought into use, according to which the water flushing is omitted, and in its place the urinal surface is coated over with a mixture of kerosine oil and lamp-black or tar. The best application for the purpose is a substance called "heavy oil," but, as this has apparently not been procurable in Malta, various substitutes have been used in its stead: a mixture of colza oil and tar in equal parts, as used at Imtarfa, appeared to me to be the most effectual, and needed only to be applied once a week. No deposit takes place on the back of the stall, and there is not the least offensive smell. Elsewhere, results have not been so satisfactory. But when this, or some similar application, is used effectively, the urinals are undoubtedly cleaner than under the old arrangements. Although water must not be distributed over the surfaces to which the oil or tar has been applied, it is necessary to flush the *drain* with water, and to wash down the floor of the urinal frequently, otherwise the floor and the drain will become foul. This is what has occurred in practically every urinal in every barrack throughout the island; urine has been allowed to dry on the floor, and so become converted into dust and pollute the air.

With the knowledge that we now have that Mediterranean Fever often occurs in an ambulant and unrecognised form, there is little doubt that infective urine has been widely distributed throughout barracks in this way. On the other hand, it has been shown that exposure to direct sunlight destroys the specific organism in a few hours (Horrocks). In some barracks, as in Upper and Lower St. Elmo, the old barracks and bastions in Cottonera Lines, Verdala, St. Francis, Marsamuscetto, Old Laboratory, the old part of Floriana, and in the detached Forts, the urinals are under cover and shielded from the direct rays of the sun. This is also the case in all the hospitals. Under such circumstances *Micrococcus melitensis* might live for several days, as Horrocks has found that it will survive for 28 days in ordinary street dust, and in "building dust." In the newer barracks, such as Tigne, New Floriana, St. George's, St. Andrew's, and Imtarfa; also at Manoel, Ricasoli, Gozo, and, of course, in all the camps, the urinals are out in the open, without covering of any kind. The duration of infectivity of the dried urine would appear in these places to be very short indeed, almost negligible. It is certainly the case that the places which have suffered most, viz., Valletta and Cottonera Hospitals, Lower and Upper St. Elmo Barracks, have urinals that would retain infectivity longer than such barracks as Ricasoli, St. George's, and Imtarfa, that have suffered comparatively slightly. Also, Floriana *New* Barracks have had fewer cases proportionately than the *Old* buildings. But in the case of the two hospitals named much more care has been taken than in barracks generally to keep the floors of urinals clean, and in these places I do not think any appreciable risk of infection can have been incurred in this way. St. George's and St. Andrew's are identical in this particular respect, but have suffered differently; and Verdala, which has fared better than any other barrack but Ricasoli, has urinals as dark, and almost as confined, as in any barrack. While there can be no doubt that every care ought to be taken to prevent fouling of the ground with urine, and to cleanse it frequently, when fouled, it can hardly be said that the fouling which has occurred affords any satisfactory explanation of the distribution of the disease during the recent epidemic.

There is another way, however, in which urinary infection may have been spread. None of the barracks in Malta are provided with night urinals. In every case the urine tub is still in use. In the older barracks it is placed on the floor outside the barrack-room door in the verandah or passage. In the newer barracks a special stand is provided. At Tigne New Barracks, St. Andrew's, and the new blocks at St. George's, the tubs are placed in an alcove behind the barrack-room, and, on the upper floor, have to be brought *through* the room, in order to be taken downstairs to be emptied.* It must often happen that urine gets splashed about on the floors. It is conceivable that infection might be spread in this way, and that the admission rate from these new, and in most respects sanitary, barracks has been raised from this cause.

Although *Micrococcus melitensis* can survive in dried dust for about a month, and it has been found possible to infect goats by feeding them on such infected dust, experimental infection by inhalation has not been fully demonstrated in regard to monkeys. In Part I of these Reports (pp. 46, 72) Horrocks detailed two experiments which indicated that "*Micrococcus melitensis*, when present in dry dust, is capable of being absorbed by monkeys"; but in the account of further experiments in Part IV (pp. 29, 31) the same observer stated that it had "not been found possible to infect monkeys with dust polluted with urine from Mediterranean Fever patients and then thoroughly dried. Goats, however, can be infected in this manner." As the enormous doses of strongly infected dust employed in these experiments are only occasionally capable of transmitting the disease, the probability of there being any habitual pathogenic property in the dust of urinals or rooms contaminated in the manner just mentioned, appears to be very remote. The possibility, however, cannot be disregarded; and although the *quantity* of the contagium may have been minute at any one point of time, it is likely that it has been constantly present in such places as Lower St. Elmo.

(*d*) The habits of the bulk of the Maltese population, as in Southern Europe generally, bring about a fouling of the ground with fæcal and urinary excreta. The offices of nature are performed not only in private, but in public, places, advantage being taken of every nook and corner that offers. Around the barracks that are situated in the old fortifications there are so many ditches and secluded spots that the whole neighbourhood is sometimes a latrine; even within barrack limits it is often impossible to prevent this fouling of the ground by the native population. Floriana Barracks (including Notre Dame Ravelin and the intermediate ground) and Verdala, also all the Cottonera Lines, are instances in point. Outside Lower St. Elmo on the shore of the harbour, and in the Jews' Sallyport, the condition of the ground is particularly filthy. Wherever building operations are being carried on, as has been the case between the Porta Reale and Floriana Barracks during the past year, the fouling of the ground is also extreme. On one morning I counted 13 separate *dejecta* immediately outside the northern end of Floriana Barracks. It may be said that wherever troops are quartered in or near native towns or villages this fouling occurs in the immediate vicinity of their dwellings. Where they are removed from this undesirable propinquity it does not exist; as, for instance, at Manoel, Tigne, Ricasoli, Imtarfa, Gozo. The civil authorities seem powerless to put a stop to this nuisance; and of course the military have no control over ground outside barracks.* However, insanitary and disgusting as this condition is, it is not easy to prove any bad effects resulting from it in regard to Malta Fever, in view of the strong disinfectant action of sunlight that has been already mentioned. Only in such places (like the Jews' Sallyport) that are covered in, would the specific micro-organism retain its vitality for any considerable length of time. So also in the streets generally, though many corners are fouled, it may be assumed that the virulence of *Micrococcus melitensis* is soon destroyed by exposure to the sun. In the fields human excrement is frequently used as manure. Horrocks has found that *Micrococcus melitensis* may survive for 20 days in manured garden soil in the laboratory; but in the open fields, fully exposed to the sun, this would only be possible at some distance below the surface, from which situation it would not be likely to be dispersed about in the air, and inhaled or swallowed by any passer by.

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* It is probable that the same thing happens, though it is not necessary, on the lower floor, in order to save trouble.

The air of the streets of Valletta and other Maltese towns is, however, polluted from another source, viz., from the underground cellars, or basements, often used as dwellings, and in which there are often water-closets of the most defective kind. These closets are very scantily flushed with water, which has to be fetched by hand for the purpose, and, supposing any inmate of the basement dwelling is suffering from Mediterranean Fever, must undoubtedly be a source of danger to the other occupants; and not only to the occupants, but to the passers-by in the streets above. The effluvia that rise from these basements are often very offensive, and obviously excrementitious: as these places are dark, and never penetrated by the sun's rays, there is no reason to suppose that *Micrococcus melitensis* would lose its virulence in a hurry in such a situation. Alternations of temperature cause currents, upwards and downwards, from these basements; and it is within everyone's experience that the current upwards is sometimes (like the effluvium) of considerable strength, and quite able to carry up micro-organisms from the closet below to the street above. In this way the men occupying barracks such as Upper and Lower St. Elmo, which cannot be approached except by passing along streets having basement dwellings of this kind, are more liable to aërial infection than the occupants of barracks such as those at Pembroke and Imtarfa, situated away from such streets and dwellings.

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* There is, I believe, one exception to this. I was informed that the troops occupying Lower St. Elmo are charged with the duty of keeping clean the Jews' Sallyport, which is used as a latrine by the natives of the neighbourhood.

(*e*) In the late Captain Hughes's treatise on Malta Fever there is a strong body of evidence in regard to the association of fever outbreaks with "insanitation"; implying by this contamination of the air of the barrack or dwelling with emanations from drains, cesspits, etc., or putrefying organic matter, or polluted soil. Fifteen separate outbreaks of greater or less extent are carefully described in which the connexion certainly appears to be one of cause and effect. I made particular enquiry of 187 patients suffering from the disease, as to whether they had been conscious of any insanitary condition, or "bad smell," in or near their quarters, which might seem to be connected with their illness. The information gained was disappointingly meagre. In only six cases was there any idea, from the patients' side, of any connexion between "bad smells" and their illness. In one case a W.C. in the officers' mess, where the man was employed, had been frequently stopped up and offensive. In two cases the regimental latrines sometimes became choked, and the men had to clear them, which was a disagreeable job. A man employed at the officers' mess in the Inquisitor's Palace, slept on the ground floor, where there were often bad drain smells.* One man (and one only) complained of the bad state of the latrines in Cottonera Lines. One serjeant complained of a bad smell in his "bunk," which was very imperfectly ventilated (Lower St. Elmo). This testimony is of very slight importance one way or the other; all one can say is that there does not appear to have been any notable or widespread offensiveness in any of the barracks sufficient to excite attention. This is, after all, what one would expect *in barracks*, where the dwelling rooms are quite disconnected from the latrines and drainage. Only in the old fortress barracks, and in hospitals, are these conditions reversed. But during the last 10 years very great improvements have been made in the condition of these old barracks, and the insanitary conditions detailed by Hughes are not, to the best of my belief, now existing in any quarters occupied by troops in Malta. The evidence collected by him is, in my opinion, strongly in favour of a causal connexion between Mediterranean Fever outbreaks, and the laying on of excrementally polluted air to dwelling rooms; but I have not been able to gather any similar evidence that would in any way explain the incidence of the disease during the past year amongst the troops.

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* This quarter (and the mess building) was evacuated shortly afterwards. When I examined it, I could find no defect in the drainage arrangements.

§ 6.

Having reviewed the influence of water, food and air as channels of infection in Mediterranean Fever, with on the whole a negative result, that is, without having succeeded in tracing any definite relationship between its mode of prevalence amongst the troops and the existence of conditions pointing to probable infectivity of these media, we are now led to the consideration of what appear to be the only other alternatives, viz., direct or semi-direct contagion, and the agency of some biting insect.

As to direct contagion, Hughes, writing in 1897, dismisses the question very shortly. "Patients suffering from other diseases, occupying beds next to cases of undulant fever, do not develop this fever, nor do the military sick attendants in fever wards suffer more from this fever than those working in other wards, or so much as soldiers in many of the barracks in Malta who have not entered the hospital previous to the onset of their attacks."

The following table is extracted from a paper by Capt. J. C. Kennedy,* and shows the prevalence of Malta Fever amongst patients and orderlies at Valletta Hospital, as compared with the garrison in Valletta, for the years 1897—1904. The figures are ratios per 1000.

	Valletta Garrison.	Valletta Hospital patients.†	Valletta Hospital orderlies.
1897	42·11	11·05	80·00
1898	22·78	29·99	163·63
1899	22·54	32·00	34·48
1900	26·68	6·44	54·05
1901	43·11	45·75	121·21
1902	16·90	34·18	48·78
1903	67·31	24·53	50·00
1904	45·42	14·43	169·23
Average ...	36·23	24·79	92·4

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* 'Journal R.A.M.C.,' May, 1905.

† Cases that have been diagnosed as Malta Fever within 20 days after admission, and cases that have been changed from S. C. Fever to Malta Fever after admission, have been excluded. Also cases that have been admitted from outside, but which may have contracted the disease inside, hospital are not included.

Captain Kennedy points out that venereal patients, and patients suffering from injuries, were much more liable to contract the disease than others, the ratio being 3·31 per 1000 venereal admissions, 2·42 per 1000 admissions for injury, and only 0·76 per 1000 admissions for all other diseases. He explains this by the facts that these patients spend a longer time in hospital, on the average, than any others (except Malta Fever); and that they are all treated in one ward, 20B, which is in communication with, indeed is part of the same room as, other wards containing Malta Fever patients. In 1905, 11 cases have apparently been contracted in Valletta Hospital, of which 8 were staying in 20B Ward and 2 in 20A Ward; the ward in which the remaining case stayed is doubtful. At Cottonera 10 cases apparently contracted the infection, of which 3 were inmates of wards in which the fever cases were treated. As regards orderlies, Kennedy states that of the 11 who contracted the disease at Valletta in 1904, 8 were doing duty in 20A, 20C, and 37 wards containing Malta Fever patients. In 1905, of the 19 at Valletta who were attacked, 11 were employed in the fever wards. At Cottonera 5 out of 7 cases amongst orderlies were similarly employed; as were the two cases of R.A.M.C. at Citta Vecchia.

Now, leaving on one side for a moment the case of the orderlies, who are exposed to various possible sources of infection, what is the most probable explanation of the occurrence of these cases of infection in patients who are confined to the hospital precincts, and in some instances to their beds? At both Valletta and Cottonera Hospitals the drinking water is above suspicion, the milk has been "pasteurised" since the middle of 1904, and the wards are absolutely free from any kind of contamination from sewer air, or latrine air, or urinal air. Whatever the sanitary shortcomings of the "Long Ward" in Valletta Hospital may be, it is certainly not exposed to any danger of this kind; neither are the other wards in this hospital, nor any of those at Cottonera. Of course, patients who are able to get up make use of the latrines and urinals of the hospital; but in neither of these hospitals has there been any failure in the water supply to latrines, leading to insufficient flushing, nor has there been any reason, even the slightest, to suspect that drain effluvia gain access to the latrine or closet chamber. The latrine for 20B Ward is certainly old and defective, and a considerable waste of water results on account of the defective fittings; also the latrine and urinal for No. 37 has a rough floor, which requires concreting. But though these conditions are insanitary and undesirable, they cannot be reasonably held to be causative of Mediterranean Fever.

The condition that appears to be the most probably effective in the causation of these hospital cases is the presence in the wards of a large quantity of disease-producing material in the bodies of the patients themselves. It is known that the specific organism is present in the blood, and is excreted in the urine; it is possibly excreted in fæces, but up to the present has not been demonstrated in the breath, saliva, or perspiration. Transmission by direct contagion is therefore not theoretically probable; by indirect or semi-direct contagion through clothing soiled with excretal discharges it is not improbable in the nature of the case, although hitherto there has been no proof of this mode of spread. The position, however, is not unlike that of enteric fever, which is now considered (in fact, may be said to have been proved) to be spread by means of "contact," *i.e.*, close association. Presumably this happens by infective urine or fæcal matter fouling the skin or clothing of the patient, and then becoming disseminated through the air, and inhaled; or finding its way into articles of food or drink, and being swallowed. We have the authority of Koch for the opinion that transmission of enteric in this way is its most important mode of propagation. A few years ago this would have been considered most unlikely, but proofs have been accumulating. I do not see that there is any essential difference between the position as regards enteric fever transmission and Mediterranean Fever transmission. Where there is a large quantity of the infective material accumulated in one place, *i.e.*, in a hospital, there the likelihood of its spread is the greater. That this spread occurs but very seldom is because the obvious precautions usually taken are sufficient; but when the number of cases (*i.e.*, quantity of specific poison present) is largely increased, it may probably happen that the precautions are not increased *pari passu*, because the labour involved increases out of all proportion to the working power present. A patient severely ill may pass involuntary evacuations twice or three times in the night. There may be (and have been) two or more such cases in the same ward; obviously the risk of dissemination of infective particles becomes much increased when this occurs. Even with the best methods of disinfection in every detail, of the person, of the clothes, of the evacuations, there must be a chance under such conditions of infective material being spread about. This seems to be a mode of propagation that cannot be excluded; it is applicable to the other occupants of the wards, and especially applicable to the actual attendants on the fever cases.

With regard to the behaviour of the epidemic among the troops in barracks, from the preceding part of this section it appears that neither water, nor food, nor air contaminated with drain emanations will explain the incidence of the disease; the one fact that stands out most clearly is that the fever has occurred in a number of small outbreaks, almost strictly localised in some place, or limited to some small body of men. Examples of this have been instanced in the case of G and H Companies, Essex Regiment, at Lower St. Elmo; A Company, Royal Dublin Fusiliers, at St. George's; the men of the Royal West Kent

Regiment that occupied the Old Barracks, Floriana. In each of these instances, where several cases of fever occurred in the same room, or same set of rooms, there was an appreciably larger quantity of infective material in those rooms, than in the barracks generally; the more there was of it present, the more likelihood would there be of the infection spreading.

There is one condition, common to Lower St. Elmo and Floriana Old Barracks, that would presumably be of importance in aiding this spread of infection. The rooms are casemates, most inadequately ventilated. If it be granted that the infective material is disengaged from the bodies of persons suffering from the disease, no better place could be found for its accumulation from day to day and night after night than a casemate such as those in question. It is extremely improbable that a thorough change of air ever takes place in these cavernous chambers. It is quite impossible that any thorough change should be effected frequently. The construction of the rooms and their size prevent it. I do not think it too much to say that the Long Ward in Valletta Hospital is in similar case as regards change of air. Though very large and lofty, the thorough change of the contained air is very difficult to effect: and as the upper windows have not (to the best of my belief) been fully utilised as outlets, I consider that there has been an accumulation of infective material in the air of this ward from day to day and night after night.

In regard to the barrack-rooms at St. George's that were so much affected (A Company, Royal Dublin Fusiliers), nothing can be said against their ventilation. But the bedcots are crowded together, so that only about 12 inches separate each pair of beds, and there has therefore been concentration of the persons, and consequently of the infective material. It may be asked in this, as in the other cases, where many barrack rooms are similarly circumstanced, why some should be affected and not others. The reply would be that it is necessary that the poison should be introduced, and probably introduced in some notable quantity; having once been introduced, the conditions mentioned would naturally favour its spread.

There are two main difficulties to be met in adopting this theory, or explanation, of the prevalence. One arises from the fact that *Micrococcus melitensis*, though often sought for, has not been found either in the air of the Valletta Ward or in the dust collected from it, and from the Cottonera Wards. The other is that it has not been found possible, so far, to infect monkeys with urine-infected dust. It must be admitted that these are substantial difficulties in the way of this explanation.

§ 7.

In regard to the question of transmission by fomites, the experiments of Horrocks, who found that *Micrococcus melitensis* could be recovered from khaki cotton, khaki serge, and blankets up to the 80th day; and of Shaw, who recovered it from blue serge up to the 78th day, show that this form of dissemination has practical importance. The necessity for disinfection of clothing, etc., is fairly obvious. The procedure that has been carried out has varied in the different corps stationed in Malta, as appears from the following statements obtained from the regimental authorities :—

Royal Garrison Artillery (Upper St. Elmo), 65th Company.—In the earlier part of the year the kit and bedding of men admitted to hospital were placed in the company store until instructions were received from the medical authorities that they should be sent to hospital for disinfection. Since the middle of August, in the case of all men admitted with "fever," the kit and bedding have been put on one side in the "Old Magazine," awaiting instructions as to their disposal.

96th Company. It has always been the custom to put on one side the kit and bedding of all men admitted to hospital. When the case was declared to be "fever," the whole kit and bedding has been sent to Cottonera Hospital for disinfection.

Tigne, 99th Company. The kit and bedding of all men admitted to hospital have been placed in company store; on receipt of instructions from the medical officer in charge of the district, either "kit," or "kit and bedding," have been sent to the lazaretto for disinfection.

1st Company. Same as in 99th Company. In about half the cases, "bedding" only has been specified, and the "kit" has not been disinfected.

102nd Company. The kit and bedding of all men admitted to hospital are placed in company store. In infectious cases a paper of questions is sent by the medical officer to the commanding officer; one of these has reference to the kit and bedding; if they have not been disinfected they are to be sent to the lazaretto for disinfection. It may be 10 days after a man has been admitted to hospital that instructions arrive as to disposal of kit.

Ricasoli, 5th Company. When a man goes to hospital, his kit and bedding are taken into the company store; if instructions come from the hospital authorities his "kit" is sent to Cottonera for disinfection, but *not* the "bedding."

63rd Company. Same as in 5th Company, except that the "bedding" is sent to be disinfected but *not* the "kit."

100th Company. Same as in 5th Company: the bedding is *not* disinfected.

Hampshire Regiment (Verdala).—When a man reports sick, his kit and bedding are brought out of the barrack room and placed in the company store. If he is not admitted to hospital, he takes his kit and bedding back to the barrack room. If he is admitted, his kit and bedding are stored in the company store, the blankets being all stacked together in order, the sheets all together, and the mattresses all together. There is no certainty that a man receives the same blanket on discharge from hospital as he handed in when admitted. Sheets and pillow slips are washed. No difference is made between "fever" cases and others. Any dirty clothing in the kit bag remains *in situ*. In infectious cases, instructions come from the hospital authorities to the commanding officer that "kit and bedding" are to be sent to hospital for disinfection on some named date. Some days, a week or more, may elapse (after the man's admission) before these instructions are received.

Lancashire Fusiliers (Lower St. Elmo).—The kit and bedding of men admitted to hospital are stored in the company stores (the prison cells being used for this purpose). The hospital authorities notify (after an interval of some days) when the kit and bedding are to be sent for disinfection. There are no means of keeping separate the kit and bedding of "suspected," *i.e.*, fever cases: but if any man is admitted with "fever" his kit and bedding are sent for disinfection on the first Tuesday or Friday that follows.

Essex Regiment (Imtarfa).—The bedding and blankets of men admitted to hospital are sent for disinfection when so ordered by the hospital authorities, but the kit remains in the man's kit bag, unless obviously dirty, in which case it is sent to the wash. Kits and bedding are stored in parts of barrack rooms appropriated for the purpose, there being no space for their disposal in the rooms labelled "company store," which are little better than cupboards.

Royal West Kent Regiment (Floriana).—Formerly the bedding of men admitted to hospital used to be left in the barrack room. Early in the summer of 1905 the practice commenced of sending the bedding of *all* cases admitted to hospital, to be disinfected, so as to be on the safe side. The kit has been kept in company store in the two kit bags, and has not been sent for disinfection; nor have the dirty articles of clothing been washed, until the man's discharge from hospital.

Royal Dublin Fusiliers (St. George's).—Until the latter part of August only the bedding of cases of Mediterranean Fever was sent to hospital for disinfection; cloth articles of clothing were exposed to the sun and brushed; khaki, underclothing, etc., was left in the kit bag *in situ* in company store. Since the beginning of September everything has been sent to be disinfected.

Rifle Brigade (St. Andrew's).—Same as Dublin Fusiliers.

From the above account it is obvious that the disinfection of the clothing and bedding of Mediterranean Fever patients has been, during the greater part of 1905, far from complete. The want of uniformity in procedure is remarkable. Assuming that infective material may be present in soiled sheets, blankets, shirts, trousers, etc., there must have been opportunity for dissemination amongst the men of the same company, or unit, in many cases. In those instances where bedding (including blankets) has not been disinfected, it has been possible for the blankets or other articles, that have been given into store by one man, to have been taken into use by another man, as it is not the general practice to label the blankets, etc., individually; the company storeman would return to a man on discharge from hospital the same blankets that he had deposited in the store on admission, if he knew which they were; but this would not always be the case. In the instances when bedding has been sent to be disinfected on instructions being issued to this effect, there was generally an interval of a week or 10 days before the instructions arrived; and during this time infection might be transferred to other blankets or bedding in contact with the infected articles. In those cases where the kit was not sent for disinfection, when the kit-bag was subsequently opened out, and any dirty shirts, etc., sent to the wash, there would be a chance of disseminating infective material. It is to be noted that, when a man goes to hospital, he generally puts on a clean shirt, etc., the dirty shirt, etc., going into his kit-bag. There is therefore some presumption that infective material might be present. When the washing day came round, sheets and pillowslips would be sent to the wash; the dirty shirt, etc., might be sent to the wash, but it would more likely remain in the kit-bag until the owner came out of hospital.

As there were 487 cases of Mediterranean Fever during the period under review, and therefore 487 bundles of bedding and kit to be handled, one would expect that if these articles were infective, the "company store men" who handle them would show some increased liability to contract the disease. But in only one case could I ascertain that a storeman had been attacked. This was Private Burch, Essex Regiment, who was admitted to hospital on June 3, 1905. He stated that it was his duty to handle the clothing and bedding of Mediterranean Fever patients, and that sometimes this had been offensive, especially after having been fastened up in a bundle for some time.

It would seem to be probable that infection might be conveyed through infective fomites; and if this be the case, the measures of disinfection that were taken—up to September—could not be supposed to prevent this dissemination, looking at the whole question broadly. If a comparison however be made between the severity of incidence in the different corps and the method of treatment of presumably infected kit and bedding, it is seen that there is no general relation between the completeness of the disinfection and the severity of the attack ratio.

	Attack ratio per 1000.
Kit and bedding disinfected—	
R.G.A., 65th Company, Upper St. Elmo	83
,, 96th ,, ,,	69
,, 102nd ,, Tigne	32
Lancashire Fusiliers, Lower St. Elmo	63
Hampshires, Verdala	27
Kit disinfected, not bedding—	
R.G.A., 5th Company, Ricasoli	34
Bedding disinfected, not kit—	
R.G.A., 63rd Company, Ricasoli	18
,, 100th ,, ,,	42
Essex, Imtarfa	88
R.W. Kent, Floriana	45
Bedding disinfected, kit sunned and brushed—	
Dublin Fusiliers, St. George's	46
Rifle Brigade, St. Andrew's	54
Sometimes kit, sometimes bedding, sometimes both, disinfected—	
R.G.A., 1st Company, Tigne	68
,, 99th ,, ,,	54

Systematic and complete disinfection has been carried out in all cases, I believe, since the middle of September, 1905.

§ 8.

The discovery by Horrocks and Kennedy of *Micrococcus melitensis* in considerable numbers in the stomach contents of two species of mosquito (*Culex pipiens* and *Stegomyia fasciata*) indicates that transmission through the medium of biting flies is a possible mode of propagation. The arguments in favour of direct contagion or aërial transmission would apparently hold good equally in regard to mosquitoes, as carriers of infection, in places such as Malta, where they abound. Granted the presence of infective material in a ward or barrack room, in the shape of hospital patients or ambulatory cases of the disease, transference to the healthy in this way becomes easily intelligible; the numerous localised outbreaks are explicable on this hypothesis, as reasonably as by direct or semi-direct contagion. The only contribution that I am able to offer to this part of the subject is to mention that, of 97 patients from whom a *definite* statement was obtainable as to their experience of mosquitoes, 31 asserted positively that they have never, or practically never, been bitten at all; 18 stated that they had been bitten very slightly; while 48 admitted that they had been bitten a good deal. Without attaching much value to these statements (which, however, I believe to be accurate as far as they go), bearing in mind the rarity with which *Micrococcus melitensis* has been found to be present in the mosquito (four times in 896 individual mosquitoes), the chances seem to be very much against the entrance of the germ into the body having taken place in this way in the case of the 49 men who were either bitten but very slightly or not at all. But the number of men dealt with is insignificant.

SECTION IV.—CONCLUSION AND RECOMMENDATION.

The chief facts ascertained in this enquiry into the prevalence of Mediterranean Fever amongst the troops in Malta have been summarised in Section III, § 1; the various modes of propagation of the disease that have been suggested by different observers have been considered in order, and, on the evidence of the facts ascertained, a negative conclusion as to their ability to explain the behaviour of this epidemic has been arrived at in regard to transmission (1) by water, (2) by milk or other articles of food, (3) by air contaminated with excremental (fæcal or urinary) effluvia; transmission (4) by direct or semi-direct contagion, or (5) through the agency of mosquitoes appears from the evidence to be more probable than in any other way; it is difficult to separate these two modes of dissemination, the one from the other, under the circumstances existing in Malta, and provisionally I think they may be considered together.

Fully admitting that no proof has been afforded in support of this opinion, I still consider that there is a high degree of probability attaching to it, and one quite sufficient to warrant the adoption of certain measures of prevention or precaution.

Whatever view be taken of the mode of propagation, the fact is undoubted that certain barracks have suffered much more than others; among these are Lower St. Elmo, Upper St. Elmo, and the old barracks at Floriana.

If considerations of economy and the maintenance of the health of the troops were the only things to be considered, probably the cheapest and most healthful course to pursue would be to evacuate these barracks altogether. If military considerations render this impracticable, I consider that an efficient alternative would be afforded if the following procedure were carried out:—

(1) Let it be recognised that these casemate barracks are entirely exceptional in their construction and need to be specially dealt with; the occupancy should be reduced from the present numbers (calculated on a cubic space of 600 cubic feet or less per head) to one which would allow 750 cubic feet *at the very least* per head, as is now admitted to be necessary in the case of all new barracks in the command. No height above 12 feet should be reckoned as available for ventilation in the calculation of this space.

(2) During the summer months tentage for 25 per cent. of the occupants of Lower St. Elmo should be drawn (as is the case in all the other barracks in Malta, except Imtarfa and Pembroke), so that the condition of the barrack rooms at night may be alleviated as much as possible in regard to heat, stuffiness and organic contamination of the air.

(3) As even under the best possible conditions, change of the air in these casemate barracks is very difficult, and accumulation of impurities on the walls and ceilings therefore much greater than in barracks of ordinary construction, all walls and ceilings of rooms and passages should be limewashed at frequent intervals, say, once a month; this would ensure the removal of dirt, the extermination (for the time) of mosquitoes, and, for practical purposes, would be a disinfectant measure. As the work could be done by the troops, the expense would be insignificant.

(4) There is sufficient evidence to warrant a presumption, at any rate, of localised infection, or semi-direct contagion: in the event of two cases of Mediterranean Fever occurring in the same room within a fortnight, the barrack room should be evacuated and limewashed, the men being accommodated in tents for the time; after this has been done, the room might be re-occupied; but if another case occurs within a fortnight of re-occupation, it should be again evacuated, and the body of men isolated as far as possible.

(5) If in any company, or small detachment, several cases occur in quick succession (*e.g.*, two in one week, or three in a fortnight) this body of men should be regarded as infected. They should be placed under canvas, or transferred elsewhere; the measures suitable for each individual outbreak of this kind can be decided on according to the special circumstances of each case. The remarkable freedom from fever experienced by the Gozo detachments of the Essex Regiment (which regiment suffered so severely at Lower St. Elmo) indicates that, if any small infected body of troops were removed from their surroundings to a detached spot (*e.g.*, Gozo, or Mellieha, etc., etc.), and scrupulous attention paid to their sanitation in every detail, the infection may be expected to die out. Once it is evident that a body of men is infected, the sooner the move is made the better; probably a very short distance would suffice; but there must be no overcrowding, and every detail of sanitation must be carefully attended to. The rooms evacuated should be fully disinfected with formalin or other disinfectant.

(6) The above recommendations refer especially to the three old barracks that have suffered severely from Mediterranean Fever; there are other old barracks of similar defective construction to which the same recommendations are applicable, though Mediterranean Fever has not been especially prevalent in them during the past year. Such are St. James Cavalier, Salvatore Counter Guard, St. Francis Barracks, Marsamuscetto, Old Laboratory, all the barracks in the Cottonera Lines, and Fort Chambray, Gozo. In all of these the recommendations as to 750 cubic feet of space per head, 12 feet of height only being reckoned for the calculation of space; frequent limewashing, and evacuation and disinfection on the occurrence of Mediterranean Fever, equally apply. Although they have not suffered in 1905, their defects are such that a prevalence of the disease is to be feared, if the infection be introduced in sufficient amount. Tentage is already authorised to be drawn for these barracks in the hot weather.

(7) In the modern barracks in Malta, which are so satisfactory in their construction and general sanitary conditions, the above recommendations do not appear to be necessary; but the principle of a stitch in time equally holds good; any succession of cases in a barrack room would indicate the advisableness of evacuation, disinfection, and isolation.

(8) The defects in the supply of water for sanitary purposes throughout the Cottonera district (including Verdala), at St. James Cavalier and at St. George's require immediate attention. The provision of an ample supply of sea water, or No. 2 water, in order to flush the latrines and drains properly is such an obvious necessity, that it is strange that a recommendation to this effect should require to be made. Increased pumping power appears to be what is wanted;

but this is a matter for the Royal Engineer department to determine. The necessity is urgent. Latrines should be flushed at least three times a day, and four times a day if water is available.

(9) The management of urinals has not been properly carried out: systematic application of "heavy oil," or some efficient substitute (such as colza oil and tar, as used at Imtarfa); the omission of water flushing for the stalls (which, strangely enough, has very generally been used along with the oil treatment); but the careful washing of the floors of urinals, and flushing of the urinal drains with water; these are the measures indicated.

(10) Where the dry-earth system of excreta removal is still in use, a removal of three times, instead of once, in the 24 hours is recommended: this will necessitate the provision of suitable receptacles for the pail contents. The present system is too barbarous and offensive to be tolerated. There is no reason why what is strictly forbidden in India should be universally permitted in Malta: I refer to the retention in the latrines of pails, full of filth, for the greater part of the 24 hours. The nearest approach possible to the *immediate* removal system (according to the Indian fashion) should be made. It is to be hoped that the dry-earth system will, before long, be completely abolished in Malta, except for temporary camps.

(11) If the above recommendations (8) to (10) are carried out, it is to be expected that the contamination of the air of barracks generally by excremental emanations, also the risks due to disease conveyance by flies, will cease; until this is the case no barrack can be considered to be in a good sanitary condition, whether in reference to Mediterranean Fever or any other infectious disease. There is one special preventive measure directed against Mediterranean Fever infection that has been carried out during the past year, viz., the boiling or "pasteurising" of milk for the troops. This requires to be continued in the strictest possible manner. As regards the married families, for whom this is more important than for the troops, it might be feasible to provide Aymard sterilisers to treat the milk supply of the large married quarters centrally, and therefore more effectually. If this is impracticable, special instruction and warning should be continually given, not only to new arrivals, but to all the married people, as to the necessity for sterilising goats' milk, or else substituting condensed milk for it.

(12) As success in dealing with this disease, as in other infectious fevers, will probably largely depend on stopping the beginnings of an outbreak, *i.e.*, carrying out the principle of *Obsta principiis;* perhaps the most important thing of all is to find out as early as possible when and where anything like an epidemic prevalence is commencing. The existing arrangements for arriving at a diagnosis are satisfactory; if, however, this could be expedited, it would be very desirable that it

should be done. But what is required, in my opinion, is some method of tracking out the cases as soon as they occur; not waiting for a final diagnosis, which cannot be arrived at for perhaps 10 to 14 days, but, examining the patient, his surroundings, habits, movements, etc., etc., whenever there is even a *probability* of the case being one of Mediterranean Fever. Information can be easily obtained at the time, which afterwards can only be got at with difficulty and labour, or not at all. The existing establishment of medical officers is not, in my opinion, adequate for this work, they being all fully employed, as it is, especially during the summer months, when the sickness is greatest. I consider, and recommend, that two extra medical officers be employed, to give their whole time to this epidemiological investigation work, over and above the work that has been hitherto, and is now being done in the laboratories and in the various hospitals. The tracking out of the early cases by a skilled observer ought to lead to important results, in the way of ascertaining modes of infection, and consequently the carrying out of effectual measures of prevention. I do not think that one medical officer would be sufficient, the ground to cover is too extensive, and the investigations must be undertaken without delay in each case; in the summer months at least two officers would be busily occupied every day. They should be employed for this purpose only.

(13) Immediate and effectual disinfection of clothing and bedding of men admitted to hospital with Mediterranean Fever, and of patients in hospital suffering from this disease, should be carried out as a matter of course. To be effectual the disinfection must be complete, not as was formerly the case.

(14) Isolation of Mediterranean Fever patients when in hospital is indicated. The difficulty is to carry it out at Valletta Hospital.

(15) The management of the Long Ward at Valletta Hospital, so as to ensure proper change of air, is a very difficult problem to solve. I am convinced that much more ventilation, a much more frequent and thorough change of air than has hitherto been the case, is required. More advantage might be taken than was the case last summer, of the existing windows in the upper storey. A new hospital is urgently required, as has been insisted on for about 30 years past.

XIV.—FURTHER MOSQUITO EXPERIMENTS.

(Continued up to the end of January, 1906.)

By Captain J. CRAWFORD KENNEDY, R.A.M.C.

(Received February 5, 1906.)

From the middle of October, 1905, until the number of mosquitoes obtainable was too small to be of experimental use, the following experiments were carried out:—

Experiment A.—Mosquitoes were collected from the mosquito nets of Malta Fever patients and the wards of Citta Vecchia Hospital; they were all without exception *Culex pipiens*, and had fed well during the previous night on the patients; they were placed in a cage (marked "A") over water and then given the opportunity of feeding each night on a monkey. A supply of mosquitoes was received daily, and from October 13 to November 12 between 600 and 700 were collected. The monkeys bitten were Nos. 93, 22, and 33.

Monkey No. 93.—This animal had been used by Major Horrocks during the summer in order to try to infect it by means of dust collected from various parts of the island and blown down its nostrils. The last time this experiment was performed was early in July, so that there was a clear interval of at least 2½ months during which there was not a trace of a reaction to the *Micrococcus melitensis* in its blood.

The mosquitoes in Cage A were placed on this monkey nightly (with a few exceptions) from October 16 to October 31, in all 11 times; and I consider that about 500 mosquitoes had a chance of biting during that time. The animal's blood was tested for reaction to *Micrococcus melitensis* on October 16, 22, and 29, and November 5, but with no result. On November 12 there was a faint reaction in a 1/10 dilution. On November 19 a faint reaction was also perceptible in 1/10 in half an hour, and this became quite distinct in one hour. On November 25 this faint reaction had disappeared; nor was any reaction obtained on the following dates: December 2, 10, and 17. On December 31 a faint reaction appeared again. On January 7, 1906, there was a more or less complete reaction in 1/20 in half an hour. On January 10 and 12, the same; but on standing for 1½ hours the reaction was complete in 1/80 and incomplete in 1/100. On January 21 the reaction had not increased and, fearing that it might again disappear, I chloroformed the animal on January 24 and made a careful *post-mortem* examination.

The glands in the femoral and the axillary regions were enlarged and more numerous than usual. The spleen and other internal organs were normal.

Cultures on plates were made from the following organs:—

Spleen—entirely cut up and impressed on five plates.
Liver—two plates.
Kidney—two plates.
Glands, mesenteric—four plates.
,, femoral—five plates.
,, axillary—four plates.

Micrococcus melitensis *was recovered from all the plates made from the axillary and the femoral glands. All the other organs were sterile.* The microbe was present only in small quantity; the axillary contained more than the femoral glands.

Monkey No. 93 was, therefore, infected with *Micrococcus melitensis.* The fact that the microbe was localised so completely in the glands and had never reached the internal organs, probably explains the unsatisfactory nature of the agglutinative reaction.

The observation of the presence of a faint reaction 12 days after the last exposure to infection is important, (1) as proving the presence of the microbe in the body at that date, and (2) as showing that it had been there long enough to cause the formation of agglutinins; otherwise the long incubation period before a complete agglutination was obtained might cast some doubt on the experiment.

The animal never had any rise of temperature.

There was no chance of the monkey becoming infected in any other way than by the bites of the mosquitoes. The conditions under which it lived were as follows:—

For the whole summer it lived in one box shut off from any possibility of contamination from infected animals by waterproof partitions. It was situated at the end of a row, so that there was no animal on its left side. The box on its right was always occupied by an uninfected animal. No animal contracted the infection accidentally during the year. On December 14 it was removed along with three other uninfected monkeys (mosquito experiments) to a mosquito-proof room in the Lazaretto which had previously been carefully disinfected and whitewashed. These three other monkeys show no sign of infection.

Monkey No. 22 was only bitten three times and was never infected. It died from tuberculosis.

Monkey No. 33 arrived in October from Bombay, and was kept under observation till November 2. On that date and regularly till December 11 the mosquitoes in Cage A were fed on it. The cage was put on 27 times altogether, and I estimate that about 100 mosquitoes had a chance of biting.

The monkey has up to date never showed signs of reacting to *Micrococcus melitensis.*

Experiment B.—Mosquitoes caught promiscuously and presumably uninfected were placed in Cage B, with water in which *Micrococcus melitensis* was held in suspension. They were fed regularly on Monkey No. 36 between November 11 and December 11.

Monkey No. 36 has never up to date showed signs of reacting to *Micrococcus melitensis.*

Experiment C.—Freshly-hatched *Culex pipiens* were collected in Cage C, and kept alive by feeding them alternately on an infected and an uninfected monkey.

Between November 3 and December 11 they were fed on Monkey No. 101 twice, on Monkey No. 27 14 times (both these monkeys were infected and contained *Micrococcus melitensis* in their blood), and on Monkey No. 14 (uninfected) 12 times.

Monkey No. 14 has up to date never shown signs of reacting to *Micrococcus melitensis.*

SUMMARY.

I. *Monkey No. 93 became infected with* Micrococcus melitensis *as the result of bites from mosquitoes* (Culex pipiens) *which had fed on patients suffering from Malta Fever.*

II. An attempt to infect a monkey by means of bites from artificially infected mosquitoes failed.

III. Attempts to convey infection from an infected to an uninfected monkey by means of freshly-hatched mosquitoes (*Culex pipiens*) were unsuccessful.

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